SCIENCE TEACHER'S WORLD

Teacher's edition of Science World • October 7, 1959

Using *Science World* in Your Teaching

Killer Wind (pp. 6-9)

General Science Topic: Weather
Earth Science Topics: Atmospheric currents, tropical storms
Physics Topics: Heat, momentum, mechanics of fluids, unusual applications of radio communications.

About This Article

August, September, and early October are well known as hurricane months along the eastern seaboard of the United States. Mr. Tozer's timely article describes the "morphology," "embryology," "physiology," and "life history"—so to speak—of the tropical storms that periodically lash our eastern coasts from the Florida keys to New Brunswick and Nova Scotia. Hurricanes are described against a background of the normal dynamics of the Earth's atmosphere. These storms present a challenge both to the theoretical physicist and to the practicing meteorologist. Moreover, they are of sufficient public concern as to have moved Congress to authorize the *National Hurricane Research Project*. Some of the activities that fall within this project are described in the article, and some recent proposals for the control of hurricanes are analyzed.

Teaching Suggestions

For a General Science or an Earth Science class you might introduce the article by putting these questions of "fact" to the class (accept a range of answers to each and write them on the blackboard, but do not give the correct answer; invite students to read the article and obtain the answers for themselves):

1. How wide can a hurricane storm be in diameter?
2. What is the derivation of the word "hurricane"? the word "typhoon"?
3. What is the difference between a hurricane and a typhoon?
4. Over which areas do hurricanes develop? Where do typhoons develop?
5. In which of the Earth's hemispheres do hurricanes occur?
6. What is a "bar-cloud"?
7. How much rain can a hurricane drop in a 24-hour period?
8. What is the "eye" of a hurricane?
9. How large may the eye of a hurricane be?
10. How does the energy in a hurricane compare with that of an atom bomb?

Topics for Assignment

Should you plan to have students discuss the article *after* they have read it, or should you assign the article for homework reading, you might make some of the following assignments:

1. Under what conditions do tropical whirls of air develop into hurricanes?
2. Describe the differences (in origin, behavior, and direction) between a hurricane and a tornado.
3. Experienced mariners can anticipate a hurricane long before it arrives; explain how they do it.
4. Describe the weather conditions in the eye of a hurricane.
5. Describe an incident in which ignorance about the eye of a hurricane proved disastrous.
6. Explain what weathermen must study to predict—a couple of days in advance—the path of a hurricane.
7. Explain why hurricanes die out after they reach land.
8. Describe the methods used since 1956 in studying hurricanes.
9. Describe some of the methods that have been proposed, or are being proposed, for controlling hurricanes or destroying them.

Should a hurricane develop within the next few weeks, you might have students follow the progress of the storm through daily observations of the weather map published in the newspaper. (*Note*: you may subscribe to the daily U. S. weather map for a nominal charge. Write to the U. S. Weather Bureau, Washington, D. C.)

Case of the Green Bodies (pp. 10-11)

General Science Topic: Conversion of energy
Biology Topics: Photosynthesis, chemical evolution
Chemistry Topics: (same as above)

About This Article

Among the many "any-schoolboy-knows-that . . . " items, one might well list: What photosynthesis is. Every "schoolboy" has been taught that photosynthesis is the process by which a green leaf "manufactures" food. Brighter students remember being taught also that chlorophyll and sunlight are necessary, and that oxygen is given off as a by-product.

It is from this very point that the article goes on to provide more recent and more refined information regarding this basic biochemical phenomenon. Attention is focussed on adenosine triphosphate as a participating compound in which energy is trapped and upon triphosphopyridine nucleotide as a hydrogen acceptor. (The student is not subjected to these formidable names in the article, but the teacher might provide them for the very bright chemistry student or the curious biology student.) The article describes in detail some basic experiments that have led to the concept of the light and dark phases in the photosynthetic process.

Topics for Class Reports

1. Describe the structure of a chloroplast.
2. Describe the chemical reactions that take place during the light phase of photosynthesis.
3. Describe the chemical reactions that may take place during the dark phase.

4. Describe the experiments that show there is a light and a dark phase in photosynthesis.

Questions for Class Discussion

1. Why is it difficult to bring about photosynthesis of sugar outside a living cell?
2. Of what importance has photosynthesis been in the evolution of life?
3. Of what importance might photosynthesis be in the future?

Elements That Are Smashed Into Life (pp. 12-15)

Chemistry Topics: The elements, the periodic table, radioactivity, transmutation, historical continuity of research in chemistry.

Physics Topics: Nucleonics, radioactivity, atomic fission, historical continuity of research in physics.

About This Article

The present article is a companion-piece to Dr. Asimov's article on "New Uses for Old Elements" in the September 23 issue. Both will prove to be excellent reading for students in chemistry and in physics classes.

After a brief account of the "evolution" of the periodic table of the elements up to the year 1937, the author relates how the "holes" in the periodic table—atomic numbers 43, 61, 85, and 87—were subsequently filled through a succession of discoveries of these missing elements: technetium 43, promethium 61, astatine 85, and francium 87. The author clearly explains how these discoveries rest on the work of Rutherford back in 1919. Dr. Asimov then goes on to describe how, beginning with the study of fission products of uranium, and continuing with studies involving bombardment of atoms with sub-atomic particles, the transuranium elements—neptunium 93, plutonium 94, americium 95, curium 96, berkelium 97, californium 98, einsteinium 99, fermium 100, and mendelevium 101—were discovered.

The article is rich in factual information: discoverers are named, dates and places of discovery are given—and the methods of discovery are indicated. Explanations of nuclear phenomena are clear and to the point. Some of the sophistication of the article is reflected in the questions that can be used for class discussion.

Questions for Class Discussion

1. Uranium, thorium, and radium are all radioactive. Explain why there is a greater abundance of uranium and thorium in the Earth's crust than there is radium.
2. How do you account for the fact that no technetium is found in the Earth's crust?
3. What evidence is there that technetium may at one time have existed in the Earth's crust?
4. Explain this statement: Despite the fact that francium was first found in the Earth, it can nevertheless be regarded as one of the man-made elements.
5. Explain why each successive transuranium element was more difficult to form and to identify.
6. What uses have been found, to date, for transuranium elements?

Molecule Juggler (p. 20)

Biology Topics: Hormones, chemical structure of proteins, metabolism (glucose).

Chemistry Topics: Organic chemistry, hydrolysis and dehydration synthesis.

About This Article

The life, work, and philosophy of a great Nobel-Prize-winning biochemist are described. Eight years!—twice as long as the entire career of a high school student—this is the time it took Dr. Sanger to make two chains of amino acids. This will impress on your students the patience and perseverance required for superb achievement in science. (Gregor Mendel, too, spent eight years on the experiments that threw new light on problems of heredity.) The detailed description of the analysis of the insulin molecule and its subsequent synthesis will intrigue bright students in chemistry and in biology classes.

The opening salutation with which the article begins ("Fellow Students"), the threads of biographical information about this great investigator, and above all, Dr. Sanger's "message" with which the article concludes, will more than encourage; they will truly *inspire* the budding young scientists in your classes.

Questions for Class Discussion

1. Give evidence to support this statement: Proteins are the most varied compounds in living organisms, and they have the most varied functions.
2. Explain this statement: Two proteins may be made up of identical amino acids, yet be different.
3. Why was insulin a good protein molecule to study for a scientist interested in exploring protein structure?
4. How did Dr. Sanger and his associates go about exploring the structure of the insulin molecule?
5. By what method did Dr. Sanger break down the insulin molecule into amino acids?
6. How did he find out the *arrangement* of amino acids in the insulin molecule?
7. Describe the structure of the insulin molecule as revealed by Dr. Sanger's research.
8. Explain the importance of Dr. Sanger's research.

Tomorrow's Scientists (pp. 21-24)

Recommended for Biology or Chemistry Club: Report and discussion.

Application to Other Projects: Culture of algae, construction of incubator, quantitative determination of total nitrogen.

About the Article

A report on James Geil's project is certainly good for at least one program of your chemistry or biology club. Some members will want to remember the details of making a quantitative determination of total nitrogen.

The procedures involved can be used to suggest other projects: *for example*, do some plants remove more nitrogen from soil than do others? Other students may be interested in the solution of minerals James used. They might want to find out whether "pieces" of plants can live in such a medium. Still others may be interested in the design of the incubator, and set out to culture algae other than those cultured by James. All, however, will be impressed with what one student has been able to do, and with the evident satisfaction this student derived.

Oceanography (pp. 16-17)

About This Article

Oceanography is a field that involves every basic scientific discipline from astronomy to zoology, and it represents a frontier that is as beckoning and intriguing as the moon. This article deals with some of the methods, observations, speculations, and projects that came before the recent International Congress of Oceanographers at the United Nations in New York. The article will broaden the scientific and cultural interests of students, whether they be studying earth science, general science, biology, chemistry, or physics. Moreover, it will provide teachers of these subjects with effective "motivations," "introductions," and "applications" in teaching a wide variety of topics in these subjects.

Topics for Discussion

1. Describe some of the special instruments used in oceanography.
2. What is project *Mohole*?
3. State some of the unsolved problems with which oceanographers are concerned.

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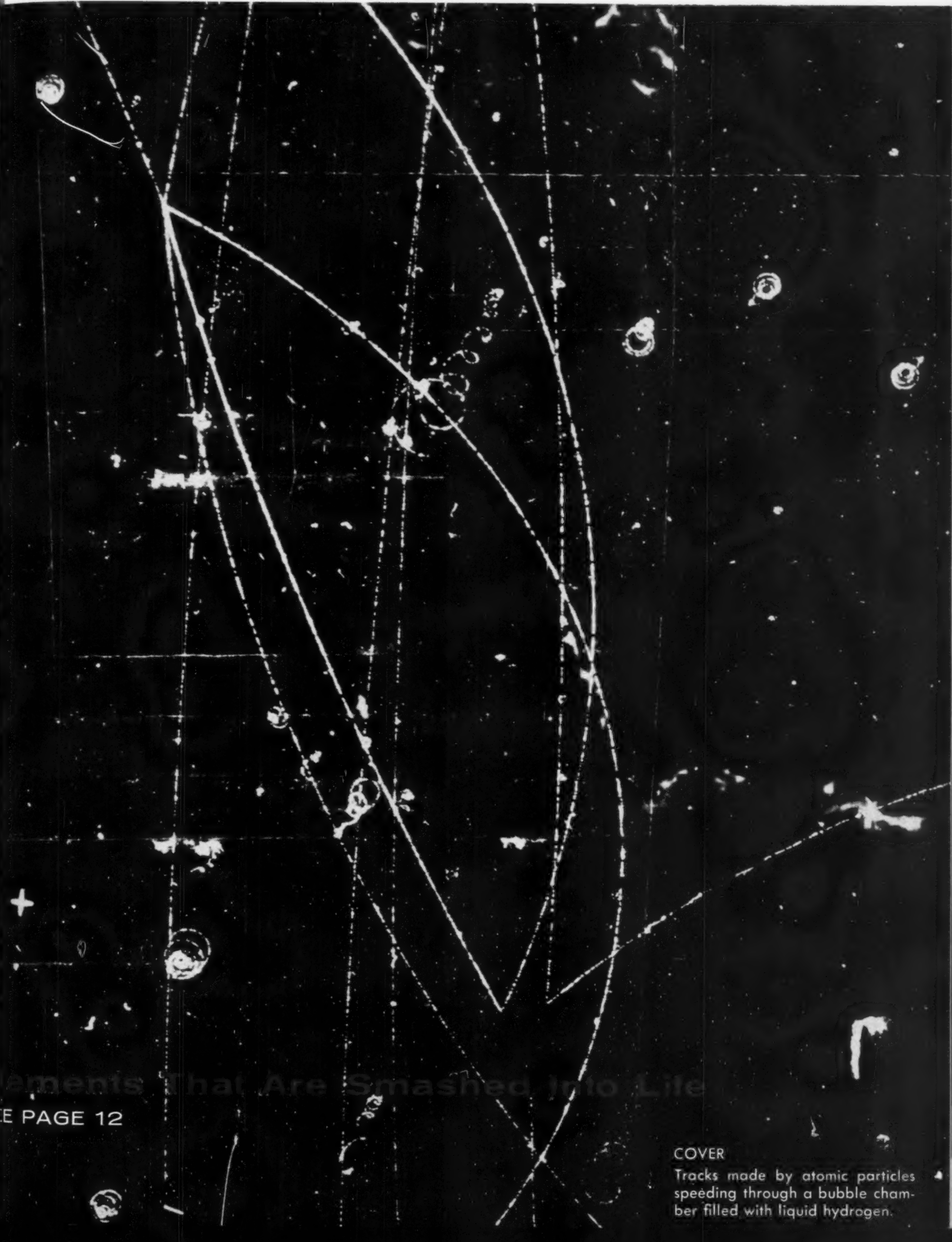

ements That Are Smashed into Life

E PAGE 12

COVER

Tracks made by atomic particles speeding through a bubble chamber filled with liquid hydrogen.

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The Staff

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CONTENTS

Features

Departments

Science in Quotes

"Science is power: the power of doing things that have never been done before. No one can set limits to what science might achieve. . . .

"Scientific research was not systematically pursued until 1600. Since then it has given man, for the first time in history, a set of verifiable statements of fact found true by all who check them or apply them, anywhere, at any time. This body of knowledge, small at first, has grown and is still growing, like a sum of money constantly reinvested at compound interest.

"Scientific research, however, is the search for pure knowledge, and it does not concern itself with applications. The practical application of scientific knowledge became more and more important throughout the nineteenth century . . . in its turn is growing at compound interest."

—PHILIPPE LE CORBEILLER
Harvard University

Letters

Steel Against Wind

Dear Editor:

How can bridges and tall buildings withstand the powerful winds they are subjected to without collapsing?

Eric Spinner
96 Seventh Street
Valley Stream, N. Y.

Answer: Engineers calculate weight and height to withstand the overturning force of the wind. This force is ultimately absorbed by the ground in which the structure is anchored.

Steel is the backbone of every tall building and bridge. The steel cage of the Empire State Building weighs 60,000 tons. The building itself weighs 365,000 tons.

Although heavy, the steel frame of a building or bridge is like a young tree that sways with the wind but remains unbroken. A building is permitted to sway a calculated distance, depending upon its height—but not enough to make its occupants uncomfortable.

The Empire State Building in New York City (1,472 feet plus a 220-foot TV sending tower) will sway about 1 inch either way at the top of the antenna in a 100-mile-an-hour wind. At the 86th floor it will sway ¼ inch either way from the center.

Depending on local conditions, bridges and buildings are designed to withstand the maximum velocity of wind. The Empire State Building is designed to withstand a velocity of 120 miles an hour. The strongest wind ever recorded in New York City was 113 miles an hour in 1954.

Effects of Radioactivity

Dear Editor:

How does radioactivity harm the human body?

Eugene Cerny
Route 1, Box 121
Shiner, Texas

Answer: Nuclear radiations can ionize molecules along their paths. As you may know, ions carry electrical charges, and if abnormal ions are produced in a person's body, abnormal chemical compounds can be formed. There is no way to predict whether these compounds will or will not be harmful or what quantity would be needed to form or produce a noticeable effect.

Nuclear radiations also involve energy. This energy is transferred to the materials through which they pass. Each material tends to absorb this energy at its own rate. Body tissue can absorb only so much energy without being damaged. Excessive amounts destroy tissues and organs.

Finally, nuclear radiations, being subatomic particles or packets of energy, can rearrange the structure of molecules and—sometimes, but rarely—atoms. The genes which control heredity are made up of molecules. Thus they are subject to change under radiation. If an egg or sperm cell—containing a gene that had been changed by nuclear radiation—were to be fertilized to form a new individual, the characteristics controlled by that gene could be changed. There is no way to predict whether this change would benefit or harm the individual. However, most such mutations fail to survive in a population where the unmutated characteristic predominates.

The Thymus Gland

Dear Editor:

What does the thymus do?

Ricky Vestar
17 Boston Place
Keene, New Hampshire

Answer: The function of the thymus is not yet known. Some scientists believe it may be a ductless gland. Its location is just above the heart, beneath the breastbone. At birth, the thymus gland weighs about half an ounce. During childhood it increases in size. Between 12 and 14 years of age, it reaches its maximum size and weight—about one ounce. As you grow older it shrinks in size. In the adult it is as small as it was at birth. Because the thymus first grows and then shrinks, scientists think it may affect the development of the reproductive organs.

What Is Sea Level?

Dear Editor:

In our physics class we learned that many things are measured at "sea level." How do we determine sea level?

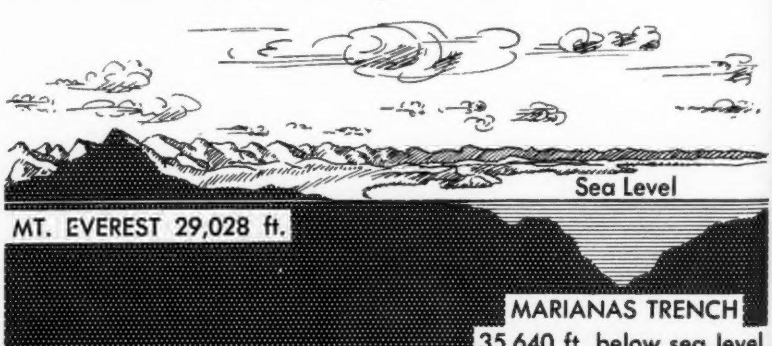
Paula Mae Geis
Watkins Memorial High School
Pataskala, Ohio

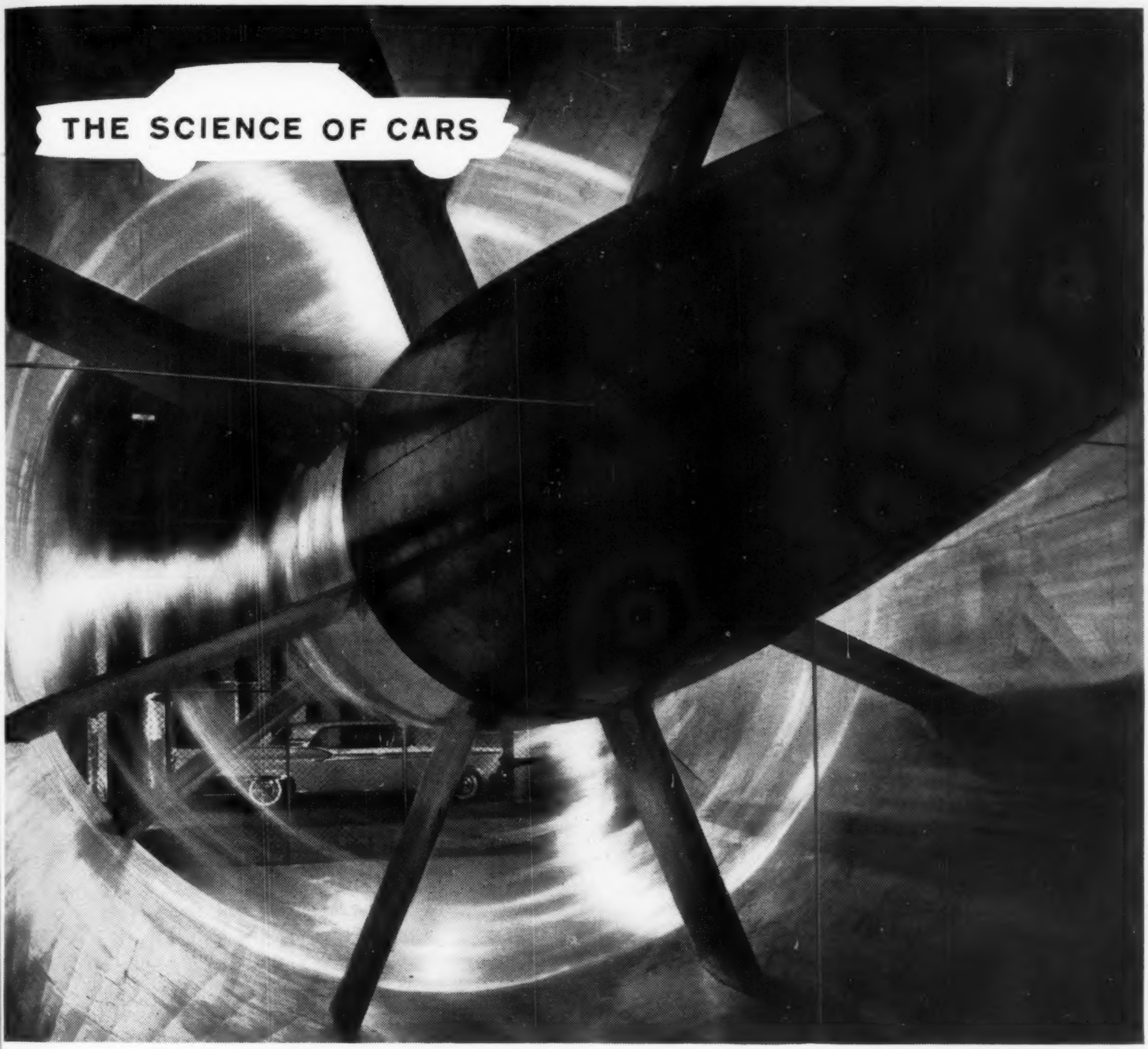
Answer: True sea level is the surface level of the ocean—since the waters of all the oceans join. But there are tides, winds, currents, and many other disturbances. Thus there is no one true sea level. But scientists have devised a way to compute a standard figure.

Since water is constantly in motion, scientists devised instruments to measure water level at different times during the day. The instruments are called "tide gauges" or "mareographs."

Readings from these instruments—over a period of time—help to establish "*mean* sea level." This is an average—the halfway point between high tide and low tide. (High and low tides themselves are averages, taken over a period of many days.) Mean sea level is commonly called "sea level."

There have been many changes in sea level during past ages for various reasons. Dr. Rhodes W. Fairbridge of Columbia University recently presented evidence to show that oceans dropped some 660 feet in 400,000 years. But sea level has not varied much over the past 2,000 years.





Hurricane Road . . .

where it's just a half hour's drive from the Sahara to Alaska

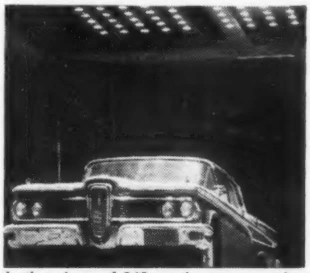
Imagine yourself at the wheel of a test car on Hurricane Road: the only wind and weather lab that combines all the world's roads—all the world's climates—in one!

In this gigantic test tunnel, an electronic brain "builds" roads and changes weather in less time than it takes to solve an algebra problem. The mammoth fan creates wind storms up to 140 miles an hour. Super sun lamps boost the thermometer from 20 below to 160 above zero. Fog, drizzle, snow and sleet—even monsoon rains—all at the twist of dials! Two huge cylinders beneath the car wheels imitate every kind of road—from flat, smooth turnpike to rutted mountain trail. The results observed in this automotive "test tube" make it possible to provide superior *insulation*, superior *weather sealing*, superior *performance* in all of our cars—in all climatic conditions.

There's excitement in the science of cars and Hurricane Road is a sample. It's just one more way science, imagination and research lead to better design and performance in the Ford Family of Fine Cars.

FORD MOTOR COMPANY
The American Road, Dearborn, Michigan

Parkas and heavy gloves are needed when engineers test cars at minus 20°.



In the glare of 240 sun lamps, even the blistering Sahara desert would seem cool.

The Ford Family of Fine Cars

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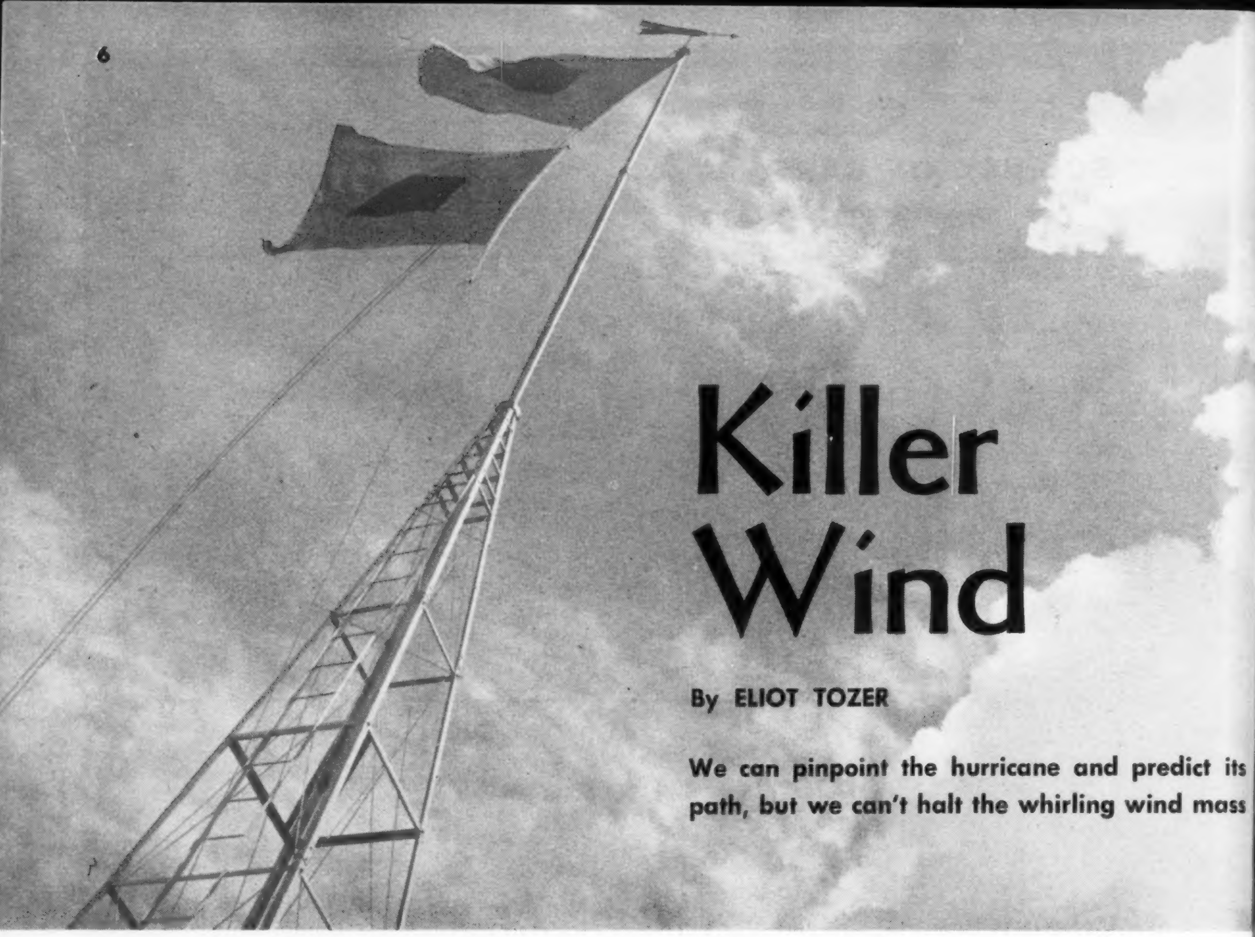


Killer Wind

By ELIOT TOZER

We can pinpoint the hurricane and predict its path, but we can't halt the whirling wind mass

Standard Oil Co. of New Jersey

Hurricane warning is flying at Cape Hatteras, N. C. Two red flags with black squares signal that storm is on its way.

RIGHT now, in the steaming river of east winds we call the trades, a tiny whirlpool is forming. Perhaps a sultry breeze has passed over a patch of sea that is warmer than the rest. Heated from below, the steaming air rises with a circular motion. At cooler altitudes, the moisture condenses and splashes down as rain.

It is a critical moment. Will the tiny whirlpool fill in and disappear, leaving only scattered showers? Or will it spin faster and faster, pulling into its vortex the equatorial air from miles around, and develop into the West Indian's fearful "huracan" or "evil spirit"?

Weather men, even though they have studied the hurricane intently—from inside and out—could not say for certain. Scores of little ripples, low pressure areas, form in the North Atlantic Trade Winds every day. Each year, some spin into tropical storms with winds from 39 to 74 miles per hour (by Weather Bureau definition), while a few (there were seven last year, two fewer than average) become hurricanes with winds from 75 to 200 miles per hour. But we don't know why.

Nor do we know why some hurricanes live out their lives harmlessly in mid-Atlantic, while others careen into our east coast, destroying millions of dollars worth of homes. But the Hurricane Hunters of the U. S. Air Force and the U. S. Weather Bureau have put their heads together and come up with possible answers.

How It Starts

At the equator, the vertical rays of the sun warm the Earth intensely. The warm Earth heats the air, which rises many thousands of feet and fans outward. Some air flows north into the upper troposphere toward the North Pole. There it cools, settles, and flows southward along the surface of the Earth toward the equator.

But this flow of air is broken up by two forces—the rotation of the Earth and friction of the warm air against cooler air—into sinking and rising currents. At 30 degrees N. (the Horse Latitudes), some sinking air flows eastward. We call these winds the Westerlies. The currents south of 30 degrees N., flowing from east to west—hot, moist, unstable—are the Trade Winds in which whirlpools form.

In one of these whirlpools everything must work together, like the players on a smooth-clicking football team, for a hurricane to develop. Beneath the whirlpool, water temperature must be at least 82 degrees F. The air itself must be unstable, that is, so hot and humid that it would not be slowed in its upward rush by cooling due to expansion. And, according to most recent theory, there must be an overlay of cooler, dryer air from the west—perhaps an errant Westerly.

Under these conditions, the small whirlpool of wind becomes a roaring funnel. Warm surface air from hundreds of miles away flows toward it and spins upward, spilling out 10

miles above as ugly looking cumulonimbus cloud.

Now in its formative stage, the hurricane "feeds" on the sun-warmed sea. Moisture picked up off the water condenses out at cooler altitudes as slashing sheets of rain. The latent heat of condensation released in the process adds to the force of the updraft. One concentric ring of stormy cloud after another forms, until the whirling mass is perhaps 500 miles across. And the whole system begins its erratic wandering toward the west-northwest, traveling at about 12-15 miles per hour.

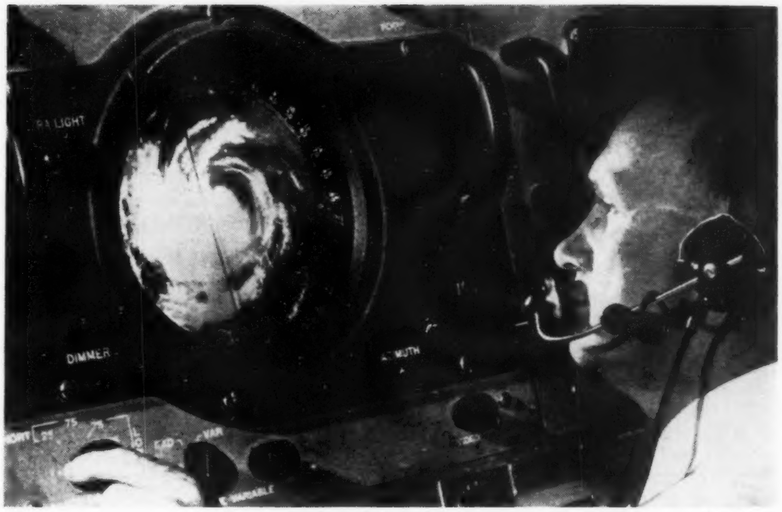
The Tell-Tale Signs

This we call "hurricane." Filipinos, Chinese, and Japanese call such a storm "typhoon" ("taifung" or "great wind"), but the two are the same. Typhoons form at the western end of the Pacific both north and south of the equator. Hurricanes spin into existence in the North Atlantic, the Caribbean, and the Gulf of Mexico. Occasionally, a full-developed hurricane forms in the eastern North Pacific (off Mexico) or the Arabian Sea, or the South Indian Ocean. None has ever occurred in the South Atlantic.

Tornadoes, smaller but much more violent than hurricanes, develop when a mass of cool, dry air overrides warm, moist air. The initiating whirlpool is often caused by the uneasy mixing of the two masses. Formed over land (usually in the southeastern and central U. S.), tornadoes last only a few hours.

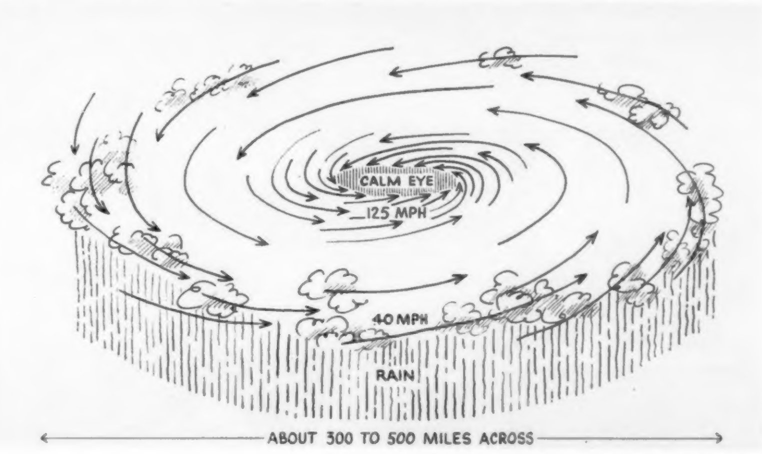
Weatherwise mariners know the hurricane is coming long before it arrives. High cirrus clouds (ice crystals) radiating from one point on the horizon are the first visible sign. They may appear while the center or "eye" of the storm is still a thousand miles away. Then a thickening hood of creamy cirrostratus—which may put a halo around sun or moon—settles over the sea. Ragged gray altocumulus, sometimes turning to copper, next comes scudding over. Now the clouds are almost touching the water.

Meanwhile the "glass" (barometer) begins to drop faster than normal, with ominous steadiness. At the same time, the temperature climbs. Winds freshen—gusty, unpleasant winds.



Bell System

Radar operator watches pattern of hurricane on scope. Storms can be detected by radar at distances up to 250 miles. Scope shows eye, winds, rain, direction.



Science World Graphic

Center or "eye" of storm is calm while 125 mph winds whirl around it. Rain and slower winds of 40 mph extend from 300 to 500 miles across as hurricane proceeds.

The sea will appear "oily," and the normal eight swells per minute drop to perhaps four per minute, as if waiting.

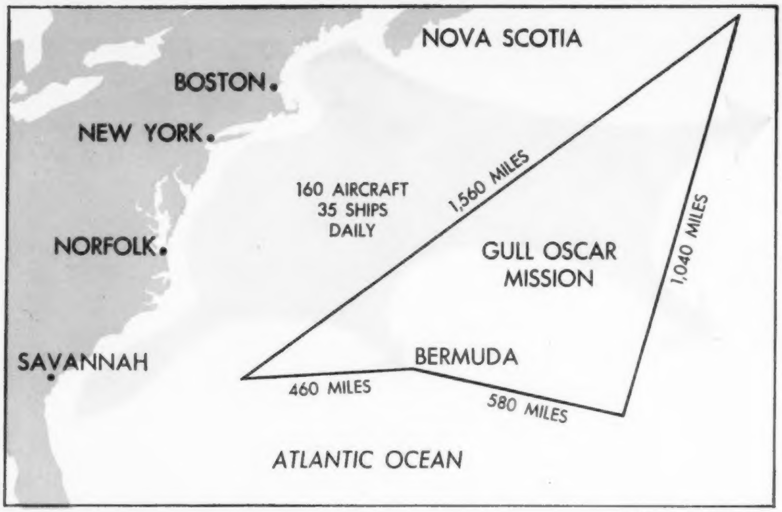
Inside the Maelstrom

Then it comes.

A black, heavy wall of cumulonimbus, the first of the several concentric rings of clouds, approaches. Sometimes called a bar cloud, it extends from near the surface to an altitude of two or three miles. It is laced with lightning, ugly yellow flashes, and torn by thunder. But the thunder is seldom heard in the screaming wind. The rain falls in torrents, then lets up for perhaps 10 minutes or a half hour until the next cloud ring marches by, and slashes down again. At Taylor, Texas, in September, 1921, 23.11 inches of rain fell in 24 hours.

In the center of this multi-ringed maelstrom is the eerie "eye," often a bowl of gentle blue sky except for a few milky stratocumulus at an altitude of one mile. Here it is hot, sometimes 32 degrees F. warmer than the outer storm—and quiet. Many times, gulls have been seen circling lazily, gathering strength to brave the screaming winds again. Average diameter of the eye is 14 miles.

Airplanes can fly in the eye with relative safety, but surface ships avoid it. The seas are wildly unpredictable, with 45-foot waves some-



Science World Graphic

"Gull Oscar Mission" is flown daily by "Hurricane Hunters," based on Bermuda. Flyers scout 3,640-mile area of North Atlantic to insure safety of ships, planes.

U. S. Air Force photo

Circular pattern of storm clouds is clearly visible. Storm center or "eye" is at upper left. Medium altitude view was taken by U. S. Air Force "Hurricane Hunter."

times clashing together from opposite directions with enough force to break a 10,000-ton ship in two.

The extreme low pressure in the eye, incidentally, sucks up the water into a plateau several feet above sea level. From this mound of choppy sea, swells may streak away in all directions at 80 miles per hour—often outrunning the storm itself.

On Sept. 18, 1926, a hurricane spun through Miami, slashing at its stucco houses and giant palm trees with 100 miles per hour easterly winds. At dawn, deceived by the sudden calm of the eye and a beautiful sunrise, scores of youngsters hurried across the causeway to swim in the surf at Miami Beach—when the opposite side of the storm roared in from the west. Many swimmers and hundreds of others were swept to their deaths by the surging tide. The Weather Bureau estimates that about 80 per cent of hurricane damage is caused by high seas and swollen rivers.

Predicting the Path

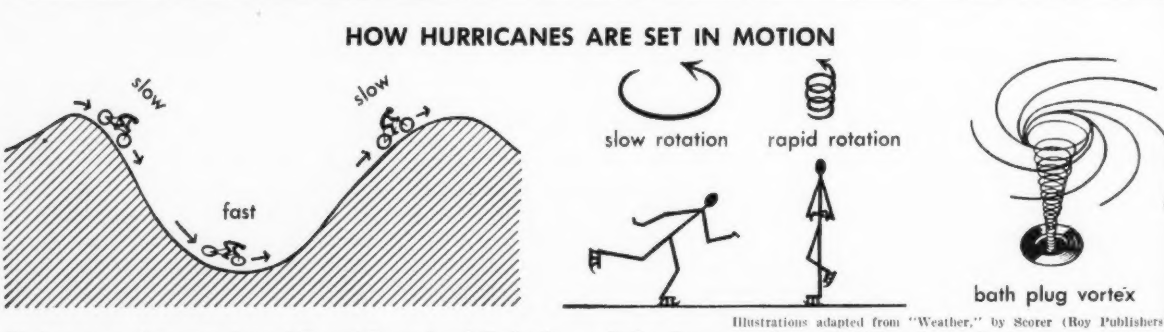
At its full fury, the hurricane's winds may reach 250 miles per hour. Strongest winds are observed in the northeast, where the screaming air is given a helpful push by the rotation of the earth.

A hurricane—even a small one—is no local matter. To understand a storm that is 150 miles across, researchers must study an area as large as the U. S.

Here's why.

High pressure areas in the Horse Latitudes, such as the Bermuda High, sometimes hover in one place, spinning in a clockwise direction. If this

HOW HURRICANES ARE SET IN MOTION



Illustrations adapted from "Weather," by Scorer (Roy Publishers)

(1) Just as cyclist goes down hill rapidly and uphill slowly, with no friction, so air moves rapidly toward low pressure troughs and slowly toward high pressure peaks. (2) If particles rotating around axis are drawn closer to axis, their speed increases, as skater increases speed by drawing limbs closer together. (3) When heated air rises and is set in motion by rotation of Earth, same thing happens as around bath plug: water is removed at center, pressure at center decreases, rotation around center increases. Hurricane has low-pressure center, high-speed winds around center.

vast mass of air meshes with a hurricane spinning counterclockwise, as a big gear meshes with a smaller one, it may start the hurricane spinning even faster.

To predict the path of a full-size hurricane a couple of days in advance, weathermen must study the skies and waters over almost a quarter of the Earth. For example, ordinarily, the Westerlies force North Atlantic hurricanes into a northerly and then northeasterly path away from the U. S. But the stolid Bermuda High may hold a storm at arm's length, so to speak, and drive it westward along its southern fringe across our eastern coastline.

Over land, hurricanes quickly dissipate because they leave behind the warm water so necessary to keep them hot and churning. Even over water, they begin to fade away after 10 days to two weeks—when they reach the cooler northern wastes of the Atlantic—and dissipate as gusty showers.

They Hunt Hurricanes

Since 1956 we have learned much about these storms. In that year Congress, concerned by rising tolls of dead and injured, authorized the National Hurricane Research Project. Workers plot the course of hurricanes by radar from the center of the project at Miami, Florida.

The Air Weather Service of the U. S. Air Force goes a step farther in its study. The Hurricane Hunters, pilots and crewmen of big, four-engined B-50 bombers, fly on 15-hour reconnaissance hops every day from seven bases in the northern hemisphere, hoping to find a hurricane.

When they do, they buckle their seat belts tight and slug their way through rain and wind to the very center. There, floating eerily in the calm, they release a dropsonde, a kit of weather instruments suspended from a parachute. As the instruments parachute toward the roiling sea thousands of feet below, they radio pressure, temperature, and humidity measurements to the radio operator in the plane. He, in turn, sends these measurements back to base, where they are wired to other bases all over the world.

More than one Strategic Air Command pilot, jockeying his big B-52 across the Atlantic, has used these reports to find a hurricane, so he could edge into its northern quadrant and pick up a red-hot ride to the U. S.

Recently the Hurricane Hunters tried a new trick. They dropped a constant-altitude instrument balloon into the eye of a hurricane. There it floated for hours, radioing reports to the 59th Weather Reconnaissance Squadron at Bermuda.

With all our new knowledge, however, it is doubtful that we will soon be able to control these one-eyed storms of the ocean—that is, divert them at will or disintegrate them. People frequently suggest that researchers blow up a hurricane with an atom bomb. But weathermen shake their heads.

They are afraid that the heat released by the bomb might cause the storm to spin even faster. Even if it did not, they point out that the energy released in an average hurricane in one second is equal to the force released by 2.5 atomic bombs. It would take a fantastic explosion to disrupt a hurricane's wind pattern even momentarily.

Still, there may be other means of control. Captain Howard T. Orville, former chief meteorologist for the U. S. Navy, suggests that a young hurricane might be broken up into small thundershowers by seeding its clouds with silver iodide or solidified carbon dioxide. With the heat of condensation released all at once, the hurricane's chain of energy production might be broken.

Robbing Its Strength

Or, full-grown hurricanes might be "starved" by cutting off the warm water supply that feeds them. Oil or colored dyes spread on the ocean surface might destroy the radiation-reflection balance, cooling the water so much that the easterly trades could not absorb enough moisture to feed the whirlpool of wind.

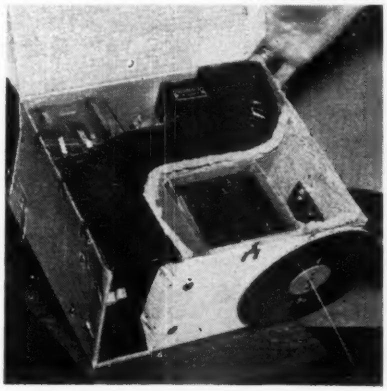
Cetyl alcohol, which has been shown to cut water evaporation by as much as 50 per cent, might also break the moisture-delivery chain, and rob the storm of its strength.

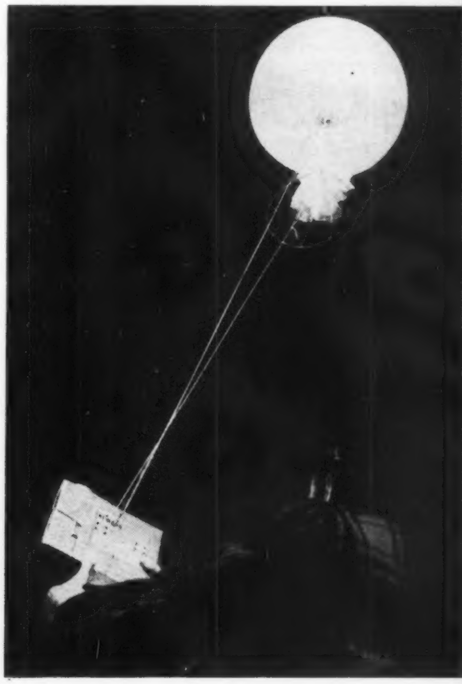
Until scientists come up with new methods of control, the Hurricane Hunters and the researchers at the U. S. National Research Project center will continue to look each late summer storm in the eye—and warn us as soon as it grows to hurricane force. And, for a while at least, those who live in the eastern seaboard will have to face this phenomenon of our restless atmosphere.

INSTRUMENTS TELL STORY

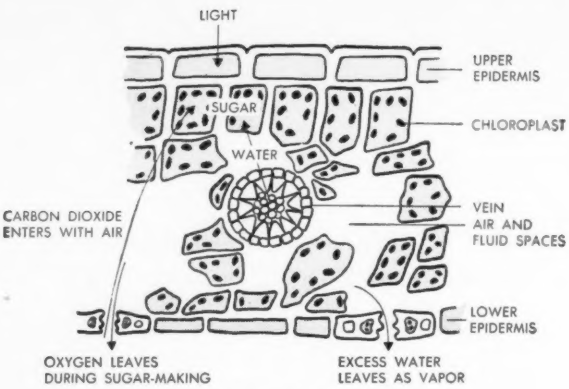
Weathermen send balloon-borne instruments aloft to measure pressure, temperature, humidity. Called "radiosondes," they broadcast data to ground stations. Rewards are offered for return of instruments if found. To measure hurricanes, instruments are dropped by parachute from plane instead of being sent aloft. Called "dropsondes," these transmit data from various heights.

General Electric photos





By ZACHARIAH SUBARSKY



CHEMICAL EQUATION OF PHOTOSYNTHESIS

$$\underset{\text{(CARBON DIOXIDE)}}{6\,CO_2} + \underset{\text{(WATER)}}{6\,H_2O} \xrightarrow[\text{(CHLOROPHYLL)}]{\text{LIGHT ENERGY}} \underset{\text{(SUGAR)}}{C_6H_{12}O_6} + \underset{\text{(OXYGEN)}}{6\,O_2}$$

Recent findings provide us with new clues to the mystery of photosynthesis

The Case of the Green Bodies

IMAGINE looking at a factory from the outside. You see tank trucks delivering nothing but mineral water and other tank trucks delivering nothing but air. From the other end of the factory, you see trucks carrying out carloads of sugar!

Fantastic, you say? Not at all! Such an active chemical factory may be right outside your window. An aura of mystery surrounds it, for only recently have scientists been able to learn what goes on inside.

This factory is a simple leaf. Simple, did we say? Not so to the scientists investigating the complex chemical processes that take place within the leaf. For here are formed the basic ingredients of life—food, without which man and all other animals would starve; and oxygen, without which life could not be sustained.

The chief business of the green factory is synthesis—the making of new chemical compounds from materials at hand. It is carried on by every living green leaf. Plants that produced chemical compounds ages ago provided the coal and petroleum we now use, to obtain heat and to run our automobiles.

Sugar is used by plants to manufacture a wide variety of other compounds. But how do plants make sugar?

From the soil the plant absorbs water. Air enters the leaf through openings known as stomates. Water and the carbon dioxide from the air enter the cells of the leaf. Chlorophyll-containing cells exposed to light convert water and carbon dioxide into a new product—sugar. Since light is required for the synthesis of sugar, the process is called photosynthesis (from the Greek for "putting together by light").

Light is a form of energy. A green leaf converts light energy into chemical energy that holds the elements together in the sugar molecule. You can prove that sugar contains energy, for when sugar is heated, or placed in contact with strong sulphuric acid, its molecules break down. The chemical energy is released as heat. It can be released as light too—as when sugar burns. Without light to furnish the necessary energy, leaf cells cannot synthesize sugar.

The Role of Light

If this were all, then carbon dioxide and water mixed in a test tube containing chlorophyll should form sugar when left in the sunlight. Nothing of the sort happens, however. Why does it happen inside a leaf cell and not inside a test tube? This problem has been occupying scientists all over the world for many years.

Scientists have discovered that in the process of photosynthesis, the cell breaks down water molecules into hydrogen and oxygen. The oxygen is released by the cells. The hydrogen, however, is held, temporarily attached to a chemical which for this reason is called a hydrogen acceptor. Eventually, this hydrogen is detached from its acceptor, and combined with carbon dioxide to form 3-carbon compounds. These are then combined to form sugar molecules. (A sugar molecule is a 6-carbon compound.)

Each of the above "steps" in the synthesis of sugar is under the control of enzymes in the living cell. These enzymes act as catalysts. What is more, these catalysts act only under certain conditions. Some may act only in the presence of chlorides. Others may require the presence of magnesium compounds. Here, then, was an explanation of why photosynthesis did not take place outside the living cell. The enzymes were missing. And even if one wanted to add enzymes, he would have to know exactly what conditions these enzymes would require.

Armed with this knowledge, scientists began to try to identify and separate the many catalysts involved in the steps in photosynthesis, and to find the conditions under which they work. What a large number there were! They include vitamin K, riboflavin, vitamin C, and a group of enzymes called cytochromes. The complete enzyme story is yet to be worked out.

Amidst all this research, several scientists began to report experiments showing that hydrogen and

carbon dioxide combine to form sugar in the dark, and oxygen is released in the process. But this synthesis takes place only *after* a leaf has been exposed to light. Light energy is trapped as chemical energy. This chemical energy is locked in the sugar molecule. But how is the light energy trapped? Where in the cell is it trapped? And in what form?

The Breakthrough

A possible answer was revealed two months ago by Dr. Daniel I. Arnon, plant physiologist of the University of California at Berkeley. On the basis of recent experimentation by several groups of scientists in various parts of the world, and on the basis of his own crucial experiments at Berkeley, he described a mechanism by which plants might trap light energy. The trapping involves two compounds whose chemical names are so long they are often abbreviated as ATP and TPN. Strange to say, both these compounds have long been known to be present in animal cells, where they act as energy carriers.

The letters TP in the abbreviation ATP stand for "triphosphate." This means that a molecule of ATP has in it three phosphorus atoms. When one of these atoms is detached from the molecule, a great amount of energy is released, and the molecule is left with only two phosphorus atoms. It is now called ADP, not ATP, the letters DP standing for diphosphate. When a phosphorus atom is attached to ADP it is changed back into ATP and a great amount of energy is stored. The addition of a phosphorus atom to a molecule is called phosphorylation. When ADP is phosphorylated (and changed to ATP), energy is trapped. This is what happens in the leaf. (The needed phosphorus is obtained by the plant from the soil.)

Clues That Were Tracked

What about the second compound –TPN? What is its role? It holds on to hydrogen molecules when water in the leaf is decomposed into hydrogen and oxygen. TPN is thus changed to $TPNH_2$.

In 1955, Dr. Arnon and two other scientists isolated chloroplasts from green cells. A chloroplast is a body inside the cell. It consists of a non-green meshwork containing a green material—chlorophyll—within the spaces of the meshwork. These scientists separated the two portions of the chloroplasts—the green portion containing chlorophyll and the non-green portion. With the green portion alone, and with light present, water was broken down while ATP and TPN_2 accumulated. Oxygen was given off. Light energy was stored in the ATP being formed from ADP. And hydrogen from decomposing water was trapped ($TPNH_2$ was being formed from TPN). But no sugar was formed.

Then the scientists removed and discarded the green portion of the chloroplasts and added the non-green portion. When carbon dioxide was added to this mixture—in the dark!—sugar compounds appeared. At the same time, the ATP and the $TPNH_2$ underwent chemical change. ATP gave up its energy, and $TPNH_2$ its hydrogen.

It would appear from these experiments that photosynthesis takes place in two stages. In stage one, known as the "light phase," light energy is trapped, water is decomposed, and hydrogen held. In stage two, known as the "dark phase," energy is released for building new molecules.

The search goes on. Will scientists succeed in unraveling the complete mechanism of photosynthesis? If they do, it may be one of mankind's greatest scientific achievements.

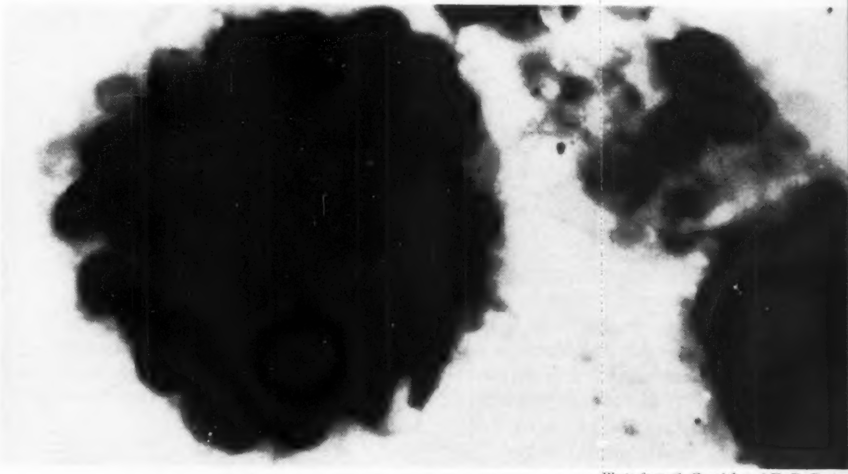


Photo from S. Granick and K. R. Porter

Spinach chloroplast is made up of 40-60 wafer-shaped green bodies called grana. Each granum consists of stack of 10 to 100 thin discs. It is in these discs that chlorophyll is located.

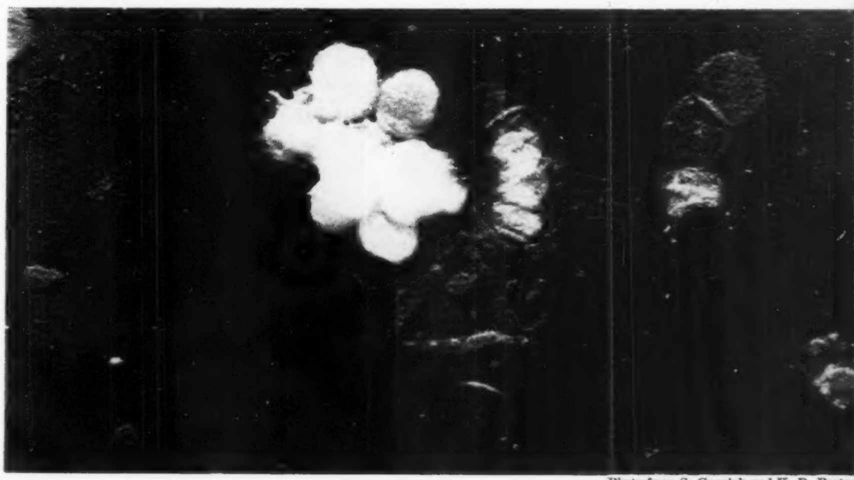
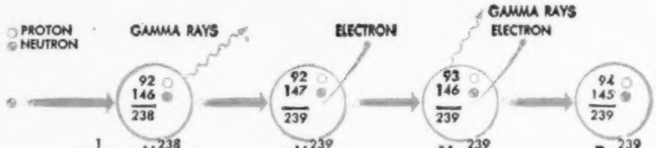


Photo from S. Granick and K. R. Porter

Spinach chloroplast as seen with electron microscope. Cluster of dense grana is in center. To right of cluster is a series of discs that look like a stack of coins that slid apart.

Westinghouse Corp.



Nucleus of uranium-238 captures neutron to emit gamma rays and form radioactive isotope, uranium-239. This atom emits high-speed electron to form neptunium-239, which in turn emits gamma rays and an electron to give plutonium-239—man-made element. Eventually plutonium releases particle, becomes uranium-235.

Elements That Are Smashed Into Life

By ISAAC ASIMOV

Using sub-atomic particles to bombard atoms, scientists have created 14 elements in the laboratory

FOR more than a century, chemists have been putting *atoms* together into combinations never found in nature. Synthetic drugs, plastics, dyes, and solvents have poured out of the laboratory in abundance, extending the natural world and improving upon it.

But all the new substances, however strange and novel, were made up of atoms of the old, well-known elements.

Then, less than a quarter-century ago, chemists found they could fashion new elements. They could build new kinds of atoms never before found in the Earth about us. Nature could be extended and man's knowledge added to in a new and more fundamental way. There are now fourteen elements which are known chiefly as products created in the laboratory – fourteen man-made elements!

In 1937, there were 88 different elements that had been detected, isolated, and studied. Of these, 81 are *stable*. That is, there are 81 elements which, unless acted upon by some kind of outside force, would remain forever unchanged.

Two more elements, uranium and thorium, are *radioactive*. That is, because of circumstances within the atoms themselves, they break down. When the breakdown happens, radiations made up of tiny particles smaller than atoms are emitted. The atoms which break down are then no longer uranium or thorium. By way of a series of intermediate steps, they become atoms of the stable element, lead.

The rate of breakdown is so slow, however, that it takes four and one-half billion years for half of any quantity of uranium to change to lead; and fourteen billion years for half of any quantity of thorium to change. For that reason, even though the Earth may be billions of years old, there is still considerable uranium and thorium existing in its crust. This assumes, of course, that all deposits of these elements had their origin at the same time as the creation of the Earth.

In addition to uranium and thorium, at least five more elements are radioactive. But when compared to uranium and thorium these break down quite quickly (the best known of these is radium).

The Score Up to 1937

The breakdown is so rapid, in fact, that any of these elements formed in the early years of the Earth must have long since decayed to almost the vanishing point. More, however, are being continually formed as products of the breakdown of uranium and thorium, the products breaking down in their turn until lead is formed. For this reason, small quantities of these five elements, forming and breaking down, are found wherever uranium or thorium are found.

These are the elements known to chemists in 1937. Now they have added fourteen more.

The atoms of all the various elements are made up of a few kinds of still smaller particles. The best-known of these *sub-atomic particles* are the *proton*, the *neutron*, and the *electron*. The protons and neutrons of a particular atom are located in a tightly-squeezed packet at the very center of the atom, this packet being called the *atom nucleus*.

Each element consists of atoms with a particular number of protons in the nucleus. For instance, all oxygen atoms have 8 protons in the nucleus, all sulfur atoms have 16, all iron atoms have 26, and all gold atoms have 79. This number is called the *atomic number* of the elements.

If the elements known in the 1930's are arranged in order—increasing by one each atomic number—it is found that there are ninety-two places. (This arrangement is called the *periodic table*. One of the earliest such tables was prepared by the Russian chemist, Dmitri I. Mendeleef, in 1869.)

The first element in the periodic table is hydrogen, with an atomic number of 1, and the last is uranium, with an atomic number of 92. The radioactive elements all occur at the higher end of the table, being included among the atomic numbers from 84 up. All the known elements below are stable.

But if 88 elements are distributed among 92 places, it is obvious that there must be four empty places. Until 1937, no elements had been isolated with atomic numbers of 43, 61, 85, or 87. These yet to be found elements were automatic "science projects." Occasionally, during the 1920's and 1930's, chemists would report having detected traces of them, but this could never be checked by other chemists.

There they remained—four holes in the otherwise neatly filled peri-

odic table; guide-posts to the creation of new elements, if chemists could find out how.

You can imagine how these holes pricked the curiosity of scientists. Fame and scientific fortune awaited the discoverer of any one of the missing elements. Here was, indeed, something to test a man's inventiveness and imaginative ability. The plodders in science speeded up their prying into places where the missing elements might be found. But a whole new hunting ground was being opened up by the work of scientists in another field. Soon there came the brave new hypothesis—"Let's not simply hunt for these missing elements, let's make them."

And these brave new thinkers were on the track!

On the Track

In 1919 the British physicist Ernest Rutherford discovered that radiations given off by radioactive elements could be used to bombard ordinary atoms. The speeding subatomic particles struck the nuclei of the target atoms and sometimes caused rearrangements of the particles within those nuclei. An atom might then end up with a different number of protons than it had at the beginning. In this way, one element was changed into another.

Rutherford used *alpha particles*, which were later found to be made up of two protons and two neutrons. Later experiments were conducted using protons alone as the bombarding particles. In the 1930's, after the neutron had been discovered, neutrons and *deuterons* (made up of one proton and one neutron) were also so used.

However, for nearly 20 years, whenever the atoms of one element were changed into those of another, the element formed was always one of the familiar elements already listed in the periodic table.

In the middle 1930's, however, a sample of molybdenum (element 42, just one short of missing element 43) had been bombarded with deuterons. A sample of it then was sent to Italy, where the chemists, C. Perrier and E. Segrè, detected traces of a new element in it. From the chemical behavior of this new element, they deduced that it must be the missing element 43. The deuteron bombardment had added one additional proton to the nucleus of some of the molybdenum atoms.

Brookhaven National Laboratory

Neutron—which has no electric charge and leaves no trail—hits a proton (nucleus of hydrogen atom) to cause three-pronged event at right. Proton shoots straight down to bottom. Two other particles—one negative, one positive—carom off, one down, one to left. Other tracks in photo are made by other particles, such as electrons, responding to magnetic field in which cloud chamber photo was made.

Eventually, Segrè suggested that element 43 be named *technetium*, from a Greek word meaning "artificial." After all, it was the first artificial element—man-made.

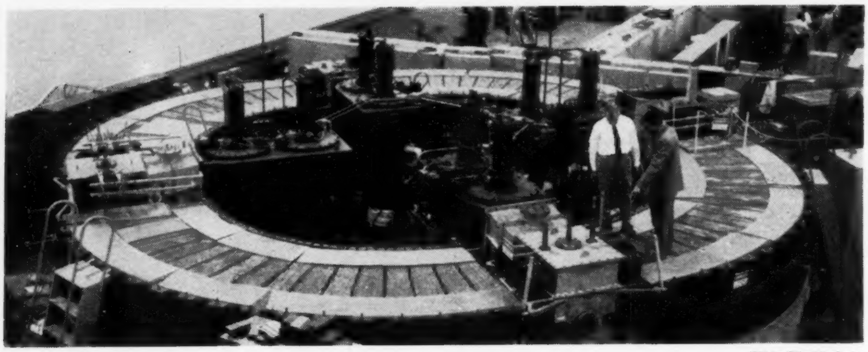
The reason for the absence of technetium in the Earth's crust was soon obvious. Unlike other elements in that part of the periodic table, it was radioactive, and had no stable varieties. One variety, or *isotope*, of technetium (every element has a number of isotopes; these differ in the number of neutrons in the nucleus, although the number of protons is always the same) has a half life of 100,000 years. This may seem long, but it is very short compared to the age of the Earth. Any technetium that formed originally in the Earth's crust is long since gone. (Some technetium, however, has been detected in certain stars. What interesting hypothesis does this suggest?)

Shortly after the discovery of technetium, it was found that certain uranium atoms, when bombarded with neutrons, underwent *fission*. That is, the atoms split into two nearly equal parts, giving off a great deal of energy in the process. This unforeseen discovery eventually resulted in the construction of the first atomic bomb.

Add Two Instead of One

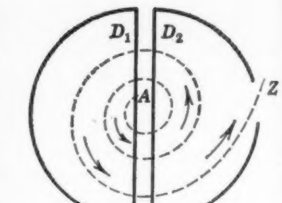
Chemists carefully investigated the fragments into which the uranium atoms split. In 1945, J. A. Marinsky and L. E. Glendenin, working at Oak Ridge, Tennessee, discovered atoms of the missing element 61 among these fragments. Like technetium, this element was radioactive. These two elements were the only ones with numbers below 84 that had no stable isotopes.

The new element was named *pro-*



Wide World photo

In synchrotron *(above)* particle is speeded up in vacuum by electromagnets and electrical energy working as team. In cyclotron *(diagram right)* proton moves in hollow half cylinders mounted between magnets that hold it on course. Proton is accelerated by alternating current.



Positively charged particle (proton) enters at A. D_2 is charged negatively. Proton is accelerated toward D_2. After proton makes half turn, D_1 becomes negative, D_2 positive. Proton is attracted by D_1, repelled by D_2, causing it to move in larger circles at higher speed, leaving at Z to hit target. Protons move in a stream.

methium, for it had been stolen out of the atomic fires of fission, just as the old Greek demigod, Prometheus, had stolen fire for mankind out of the atomic furnace of the sun.

Missing element 85 posed a problem. Technetium (43) had been formed from molybdenum (42), which meant the addition of one proton to the nucleus. However, the element below element 85 was polonium (84), and that was radioactive and very unstable, so that it existed only in traces. Not enough could be isolated with which to work.

So chemists began with bismuth (83) and bombarded it with alpha particles, which you will recall are made up of two protons and two neutrons. In this way, two protons were added to some of the bismuth atoms, and element 85 was formed in 1940. The new element was named *astatine,* from a Greek word meaning "unstable."

As for element 87, this was actually found first in the Earth's crust, after all. Theoretically, the disintegration of uranium—if it occurs step-by-step on the way to becoming lead —would include the formation of element 87. So few atoms disintegrate in this way, however, that the element was present in too small a quantity to detect, until chemists improved their techniques. In 1939 Mademoiselle M. Perey of France showed that element 87 existed in uranium minerals. Eventually she named this element *francium,* in honor of her native land.

It also turned out that very small quantities of astatine were formed in uranium breakdown. However, the most nearly stable variety of astatine has a half-life of only 8 hours, while the most nearly stable variety of francium has a half-life of only 20 minutes. It is no wonder, then, there was trouble locating and identifying these elements.

By 1945 the list of elements from 1 to 92 was complete, but meanwhile the periodic table had opened up at the upper end. Elements with atomic numbers higher than 92 of uranium were discovered. These elements beyond uranium are known as the *transuranium elements.*

Remember that from 1939 on, chemists had been eagerly studying uranium fission. In 1940 it was discovered that the chief uranium isotope did not split under neutron bombardment. It absorbed the neutron and underwent changes that resulted in an additional proton in its nucleus. In other words, element 93 was formed. Furthermore, an occasional atom of element 93 underwent changes whereby one of the neutrons in its nucleus became a proton, forming element 94.

Transuranium Elements

In 1940, E. M. McMillan and P. H. Abelson at the University of California identified element 93. Later in the same year, a group of researchers, including McMillan and Glenn T. Seaborg, identified element 94. Since uranium is named after the planet Uranus, the new elements beyond uranium were named after the planets beyond Uranus (which are Neptune and Pluto). For this reason, element 93 is *neptunium,* and element 94 is *plutonium.*

Both are radioactive, of course, as all transuranium elements proved to be. Neptunium, in breaking down, formed much more francium than uranium did. Thus, more francium is available through man-made experiments than from the Earth's crust. Francium can therefore be considered a man-made element.

As it turned out, there are neptunium and plutonium isotopes with half-lives in the millions of years. This is stable enough to allow these elements to be prepared in considable quantity. Moreover, the quantities prepared will keep indefinitely —at least during the puny stretch of human generations.

Enough plutonium was prepared to allow it to be used as a starting material for still higher elements. In 1944 and 1945, plutonium was bombarded with subatomic particles by Seaborg and his co-workers, and elements 95 and 96 were formed. These were called *americium* (in honor of the United States of America) and *curium* (in honor of the Curies, who discovered radium).

In turn, americium and curium were bombarded with alpha particles by the Seaborg group. In 1949 elements 97 and 98 were formed. These were named *berkelium* and *californium,* after Berkeley and California, where the university was located, as you may have supposed.

However, each successive element was harder to form and identify. The starting material became more difficult to accumulate. There is less plutonium than uranium, and less curium than plutonium. In addition, each successive element became more unstable. The most nearly stable americium isotope has a half-life of 8,000 years. For curium, ber-

kelium, and californium, the figures are, respectively, ninety million years, 7,000 years, and 700 years. Californium was identified at a time when only 5,000 atoms of it had been accumulated.

By 1955 chemists produced small quantities of element 99 and element 100 by bombarding plutonium with neutrons.

Element 99 was named *einsteinium* and element 100 *fermium*, after Albert Einstein and Enrico Fermi, two world-renowned theoretical physicists who had recently died.

To go past element 100, it was necessary to start with einsteinium, which existed only in minute traces, far too small to see under the most powerful microscope. This was bombarded with alpha particles. It took several hours of bombardment to produce even one atom of element 101. The experimenters so arranged things that when an atom of element 101 was formed, its breakdown by spontaneous fission caused a fire-bell to ring. However, the fire department put a stop to this.

In any case, element 101 (with a half-life of about one hour) was identified as a result of the formation of just 17 of its atoms in 1955. It was named *mendelevium*, in honor of Mendeleef, who had devised the periodic table.

Score Raised by 14

To go past 101 is a real problem. There is not enough fermium or mendelevium to bombard. Elements of lower atomic number must be used, and more protons must be added at one time. Particles containing up to six protons were used in bombardments. In 1948 it was reported at the Nobel Institute in Stockholm, Sweden, that some atoms of element 102 had been formed. This was called *nobelium*. However, chemists are having trouble repeating the experiment. For the moment, the name nobelium is not official.

No doubt, chemists will reach still higher and produce still more new elements, but it is getting more and more difficult, and the products are getting more and more unstable. Perhaps the end of practical achievements in this direction is in sight.

But still the present score shows fourteen man-made elements: technetium (43), promethium (61), astatine (85), francium (87), neptunium (93), plutonium (94), americium (95), curium (96), berkelium (97), californium (98), einsteinium (99), fermium (100), mendelevium (101), and, possibly, nobelium (102).

What can man do with these man-made elements? One has turned out to be extremely useful. Plutonium (which, along with neptunium, we now know exists in traces in uranium minerals, so that it is not entirely man-made) can be used as an atomic fuel. A plutonium nuclear-reactor is being built in Michigan.

Certain compounds containing technetium atoms have been found to be better rust-inhibitors than any other known compounds. Technetium will probably never be plentiful enough to be used in car radiators. However, study of its behavior in the laboratory will help us better understand the process of rusting.

The main use of these man-made elements, however, is nothing that one can easily put his finger upon. It lies in the field of theory. By studying the new elements, chemists and physicists are learning more about the structure of the atom. And what can be more valuable than to add to man's knowledge of the world in which he finds himself.

The Synthetic Elements

Atomic Number	*Name*	*Discoverers and Date of Discovery*	*Source of First Preparation*
43	Technetium	E. Segre and C. Perrier. 1937	bombardment of molybdenum with deuterons.
61	Promethium	J. A. Marinsky, L. E. Glendenin, and C. D. Coryell. 1945	found as a fission product of uranium.
85	Astatine	D. R. Corson, K. R. MacKenzie, and E. Segre. 1940	bombardment of bismuth with helium ions.
87	Francium	M. Perey. 1939	found as a radioactive decay product of the naturally occurring element actinium.
Transuranium Elements:			
93	Neptunium	E. M. McMillan and P. H. Abelson. 1940	irradiation of uranium with neutrons.
94	Plutonium	G. T. Seaborg, E. M. McMillan, J. W. Kennedy, and A. C. Wahl. 1940	bombardment of uranium with deuterons.
95	Americium	G. T. Seaborg, R. A. James, L. O. Morgan, and A. Ghiorso. 1944-45	irradiation of plutonium with neutrons.
96	Curium	G. T. Seaborg, R. A. Jame and A. Ghiorso. 1944	bombardment of plutonium with helium ions.
97	Berkelium	S. G. Thompson, A. Ghiorso, and G. T. Seaborg. 1949	bombardment of americium with helium ions.
98	Californium	S. G. Thompson, K. Street, Jr., A. Ghiorso, and G. T. Seaborg. 1950	bombardment of curium with helium ions.
99	Einsteinium	A. Ghiorso et al. 1952	in first thermonuclear explosion.
100	Fermium	A. Ghiorso et al. 1952	in first thermonuclear explosion.
101	Mendelevium	A. Ghiorso, B. G. Harvey, G. R. Choppin, S. G. Thompson, and G. T. Seaborg. 1955	bombardment of einsteinium with helium ions.
102	Not yet named	A. Ghiorso, T. Sikkeland, J. R. Walton, and G. T. Seaborg. 1958	bombardment of curium with carbon ions.

Science in the news

The Oceans: Frontier of Science

Oceans offer as much challenge for exploration and discovery as outer space. Two thirds of the Earth's surface is covered by water. Yet we know the surface of the moon better than we do the floor of the Atlantic.

A meeting recently held at the United Nations may help remedy this situation. An International Congress of Oceanographers—first of its kind—attracted more than 1,100 scientists from 45 nations to New York. Oceanographers probe the seas, and study the animals and plants that live in it.

Some of the oceanographers sailed into New York harbor on special research ships. Seven of these floating laboratories—from Russia, France and the United States—were on display in the harbor during the meeting from August 31 to September 12.

Aboard the ships were ingenious new scientific instruments for underwater research. Deep-sea cameras had flash attachments that were triggered when the camera touched bottom. Other instruments used sound echoes to measure water depth. Still others were used to analyze sea water and measure water temperature. Perhaps the most interesting device was a "diving saucer" aboard the *Calypso* from France. Captain Jacques Cousteau designed the "saucer" to dive a quarter mile under water. It moves along the bottom by squirting water out of nozzles in its rim.

Problems to Be Solved

There are many practical and scientific problems to be solved. A rapidly increasing world population will soon make heavy demands on the fish and food resources of the sea. Beneath the bottom of the sea are untapped oil fields. Sea water can be made to yield minerals. Oceans control climate, and winds drive oceans—weathermen would like to know more about these.

Scientists at the United Nations were also interested in asking and answering fundamental questions. Where did sea-water come from? How were the ocean basins formed? Is the sea getting warmer? Are continents drifting apart?

"The first question," said Dr. Roger Revelle, president of the Congress, "is why is there an ocean at all? No other planet has an ocean as far as we know."

Dr. Revelle, director of the Scripps Institution of Oceanography at LaJolla, California, said, "The Earth today consists of a liquid core, probably of molten iron and nickel at approximately 4,000 degrees Fahrenheit. A mantle of black and heavy rock, 1,600 miles thick, surrounds the molten core." An outside crust of slag—refuse from melting rock and metal three to 25 miles thick—surrounds the mantle.

On this crust is the hydrosphere—the water envelope of the Earth—and the atmosphere. "The Earth is something like a wet golf ball surrounded by gas," he said. "When we ask how the slag and the water came to the surface the answer probably is that they were squeezed out of the center by volcanic activity."

Scientists have found trenches on the ocean floor, some seven miles below sea-level. Mountains—almost as high as Mt. Everest—rise up from the floor. A detailed history of the Earth and the life upon it might be hidden in ocean sediment.

Great excitement was generated by the American plan to drill down through the Earth's crust—under the ocean, where it is thinnest. Scientists hope to learn what's inside the Earth.

The project is called "Mohole," in honor of Prof. Andrija Mohorovicic of Yugoslavia, who discovered the boundary between the Earth's crust and mantle.

Project Mohole will take about four years and cost about $15,000,000. Scientists asked the U. S. Government to provide $2,500,000 for the first step. General Motors has offered about $1,000,000 worth of Diesel drilling equipment at a rental of $1 a year.

Another scientific question discussed: Are the continents drifting apart? Some evidence shows the rate of drift may be roughly one yard every 1,000 years. But some people believe the continents are being squeezed together. One thing is certain—the continents are not standing still.

Are Continents Drifting?

Dr. Maurice Ewing, head of Columbia University's Lamont Geological Observatory, believes that more evidence is needed to settle the question of continental drift. Observations show a great chasm—possibly 40,000 miles in length—along the floor of the Atlantic Ocean. This rift runs north through the Arctic Ocean and south around the tip of Africa into the Indian Ocean. This separation produces tension in the Earth's crust. It may be part of the mountain-building process which causes earthquakes (*see September 23 issue*).

The oldest chasm—100 million years old—is in the Pacific. Scientists ask why no one has ever found a fossil in the sea that is more than 100 million years old. (Fossils are traces of plants or animals preserved in the ocean bottom or Earth's crust.) Why is no evidence of ancient fossil life found on the ocean

Woods Hole Oceanographic Institution

Oceanographers frequently risk lives to get water samples to study temperature and salinity of sea at various depths.

Lamont Geological Observatory

Magnetometer, to measure variations in Earth's magnetic field, is lowered from *Vema* to investigate magnetism in crust.

floor? There is ample proof that plants and animals lived on land millions of years before this. Perhaps a clue will be found in the great chasms in the ocean.

These great canyons may be related to another discovery—underwater rivers. Some of these underwater rivers are much larger, wider and more powerful than the Mississippi River. Tremendous currents exist in the oceans—beneath the surface.

Scientists know that these currents control life in the sea. By sweeping phosphates and other minerals upward from the sea bottom, these currents spread fertilizers that nourish plant life in the sea. In turn, animal life is nourished by feeding upon the plants.

Scientists believe that the circulation of the oceans also is related to the world's weather—but they would like to know more.

Careers in Oceanography

Opening the meeting, U. N. Undersecretary Philippe de Seynes said, "The Babylonians represented the seas as an infinite mass from which the land erupted like a round mountain. The Greeks visualized a circular river flowing around the contours of habitable land." In the transition from mythology to science, he observed, "the ocean has kept its mystery and its fascination."

The seas have always fascinated men and women, but the subject has been overlooked by many students choosing a career. Mathematicians, physicists, chemists, biologists, engineers, and scientists of all kinds are needed to help solve the sea's mysteries and harness its great resources and power.

Magnetism and Moon

The Soviet rocket that hit the moon relayed two important bits of information back to Earth before it was probably vaporized by the impact. Soviet scientists reported there was no evidence that the moon has a magnetic field. And there was no evidence that radiation belts surround the moon.

This may be interpreted to mean that the moon is cold and solid all the way through. If this interpretation is correct, then the liquid core believed to be in the center of the Earth may be responsible for the Earth's magnetic field. The rotation of the Earth around this liquid core—believed to be molten metal—may generate the Earth's magnetism.

Absence of a magnetic field on the moon goes hand in hand with the absence of radiation belts. Electrically charged particles coming from the sun would have been trapped by a magnetic field on the moon.

(Two radiation belts surround the Earth at altitudes of 2,000 miles and 12,000 miles. These belts were discovered by the American physicist James Van Allen. See October 7 issue of *Science World*.)

U. S. to Orbit Moon

Soviet finds also seem to indicate that the moon has no atmosphere. Any air the moon may have had millions or billions of years ago was probably swept into space.

All these deductions come from measurements—transmitted to the Earth—made before the rocket crashed. Much more valuable information will be relayed by a U. S. satellite which is planned to *orbit* the moon. It will be a "paddle-wheel" satellite similar to the one now orbiting the Earth.

The "paddle-wheel" satellite will have two devices for recording magnetism on the moon. One is a "search coil." This measures the strength of the magnetic force in one direction—probably along the center axis of the satellite. The other is a "flux-gate magnetometer," to record another component of magnetism.

If both devices prove sensitive enough to detect any magnetism at all in the vicinity of the moon, observations from the two will be compared. From this comparison, it may be possible to calculate the direction and strength—if any—of the moon's magnetic field.

Measuring Magnetism

It is more difficult to measure a magnetic field from a satellite than in a laboratory or one of the ships of the U. S. Coast and Geodetic Survey.

The usual way of measuring the magnetism of the Earth is with a magnetometer. This device consists essentially of a magnetic needle and an index for observing its deflection. In a simple magnetometer, the needle is pivoted and carries a pointer that swings over a horizontal scale.

Sometime in the future, when the first American rocket crashes into the moon, a television camera may be mounted in the nose. During the dive into the moon, the camera would transmit from 10 to 100 pictures. Persons watching on Earth could experience some of the thrill of sitting in the nose of the rocket during the dive.

Lamont Geological Observatory

Piston corer is being lowered from *Vema*. When corer is on sea floor, explosives ram tube down, force in samples.

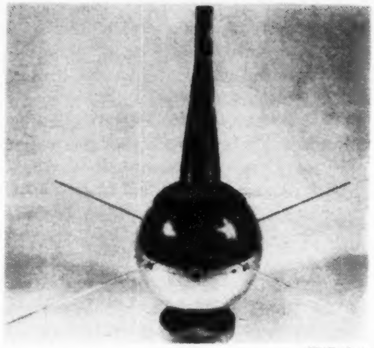
Wide World photo

After explosive charge has generated sound waves under water, scientist reads hydrophone record to help map bottom.

Woods Hole Oceanographic Institution

In lab aboard research ship *Atlantis*, samples of ocean water are analyzed for their oxygen and carbon dioxide content.

Science in the news



UPI photo

Expected to circle Earth for 30 or 40 years, this "ice cream cone" satellite was shot into orbit by Vanguard rocket.

UPI photo

Satellite's instruments were designed to study Earth's magnetic field, solar X rays, and conditions in outer space.

Bees as Killers

The bee is almost as deadly as the rattlesnake statistically, and perhaps a faster killer.

During a five-year period the common bee chalked up a grand total of 52 persons known to have died from bee stings. The notorious rattlesnake accounted for 55 deaths.

The Hymenoptera—bees, wasps, hornets, yellow jackets, and ants—killed 86 persons. In contrast, all poisonous snakes together—rattlers, cottonmouth moccasins, coral, and "unidentified"—killed 71 persons. Death from bee stings was usually faster. Several hours usually passed between snake or spider bites and the victims' deaths, while most hymenoptera stings resulted in death within one hour.

More children died of snake bite than from stings, reports Dr. Henry M. Parrish of the University of Vermont College of Medicine, Burlington. This is probably due to the fact that bee sting-deaths are actually severe allergic shock reactions, and the person must have been sensitized to the insect venom by previous stings.

Bee venom is made up of several toxic components. The chief one is apitoxin. When the sting of a bee injects this poison, enzymes in the toxin cause a breakdown of cell protoplasm and the liberation of histamine.

While venom poisoning cannot be classed as a major medical problem, Dr. Parrish says, it is much commoner than formerly recognized.

Hep Plants

A new record album entitled "Music to Make Plants Grow" may soon be on the best seller list.

For a half-hour daily, native climbing shrubs of the Pothos family in India "listened" to recorded flute music. They listened every day, between 5 and 6 p.m., for 30 days to the piece played by a leading Indian flutist. The same number of plants of "almost the same vigor and height" were grown without the benefit of music.

At the end of the experiment, conducted by Dr. Stella Ponniah of Tiruchirapalli, India, increases in plant growth were observed. Average height increased by 25 per cent; average number of leaves by 50 per cent; and average length and breadth of leaves by 30 per cent over the plants not exposed to music. Treated plants had about twice as many roots.

The Indian scientist pointed out that a good deal of research has been done in her country in this field. Researchers have been studying the growth of plants when excited by live musical sounds originating from various stringed and wind instruments. There has been no other work reported, so far as she knows, on plant growth as related to recorded music. (*Science World* reported Marcia Riley's science project, entitled "Are Plants Music Lovers?" in the September 9 issue.)

Space Capsule Heat

Can a capsule carry a man into space and return him safely to earth?

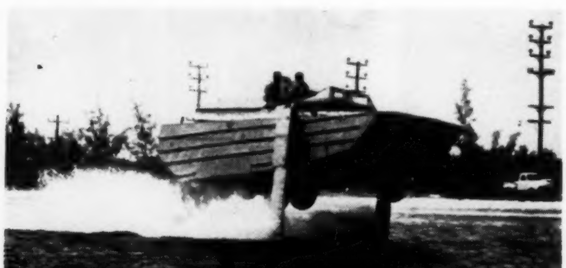
Engineers designing such a capsule tested one from Cape Canaveral—and the temperature inside never exceeded 100 degrees Fahrenheit. Outside the capsule the temperature rose above 3,000 degrees Fahrenheit.

Many refinements remain to be made, however, before the National Aeronautics and Space Agency (NASA) will feel confident that the capsule is safe enough for a man.

The capsule and its rocket climbed to an altitude of "nearly one hundred miles," an NASA report said. It reached a speed of almost 15,000 miles an hour. No figure was released on the distance traveled.

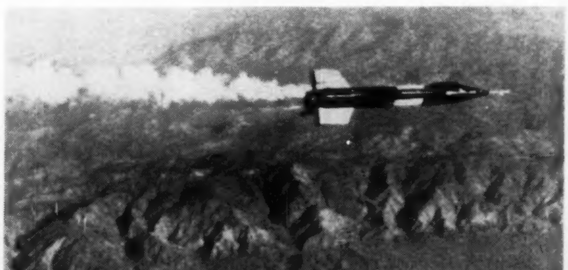
Vital additional information on heats, temperatures, and other phenomena were expected from recording tapes included among the 200 pounds of instruments carried aboard the capsule.

The shield of the nose cone was designed to overcome heats above 3,000 degrees by "ablating" or melting away. Cone was made of an alloy of nickel, chrome and iron named Inconel.



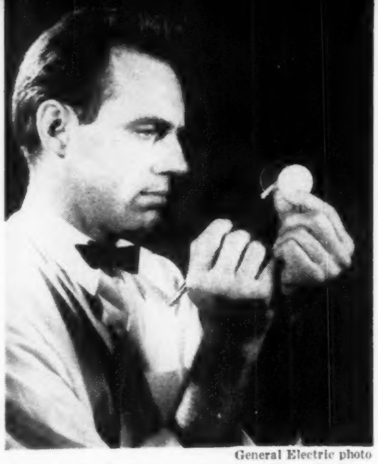
Wide World photo

Hydrofoils (not visible in this photo) at lower end of arms enable "Flying DUKW" to ride several feet above the water at increased speed in this test at Stratford, Connecticut.



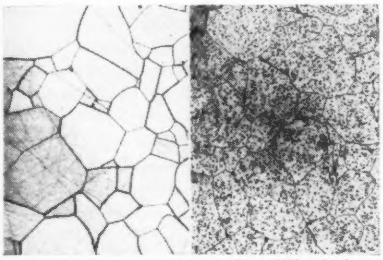
UPI photo

"Everything worked perfectly" said pilot Scott Crossfield of first powered flight of experimental X-15 rocket plane, which roared 1,400 mph above desert in four-minute test.



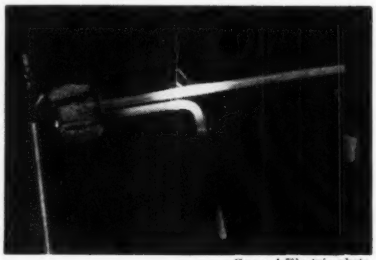
General Electric photo

Inventor of new ceramic, Dr. Robert Coble, compares transparent "Lucalox" with sample of conventional ceramic.



General Electric photo

Pores in conventional ceramic *(right)* scatter light, but Lucalox eliminates pores to pass 90 per cent of light.



General Electric photo

Blow torch heats fused quartz which bends at 2350 deg. F., but Lucalox holds 50-gram weight at 3200 deg. F.

New Ringworm Drug

A new British antibiotic, Fulvicin, developed specifically to fight athlete's foot, barber's itch, and ringworm of the scalp, body and nails, has been approved by the U. S. Food and Drug Administration.

Fulvicin is fungistatic rather than fungicidal—preventing the growth of the infecting fungi but not directly killing them. The fungi live on keratin, a substance found in the outer layer of human skin cells, which are constantly being shed and replaced. The antibiotic, taken *orally*, works its way through to this outer skin layer and makes keratin unusable as fungi food.

Heat Shields in Space

At least three types of heat shields are being developed for the nose cone of the Mercury capsule that will carry the first American into space. The heat shield tested recently at Cape Canaveral *(see page 18)* is one of these three—the ablation type.

The National Aeronautics and Space Administration has several varieties of ablating materials under development. These materials flake off, melt, or vaporize as they grow hot, thus carrying away heat from the capsule.

The nose cone tested recently was made of a nickel, chrome, and iron alloy. Another ablating material is a mat of glass fibers and resin. At least one other material already exists—the ablating blanket for Atlas nose cones. The composition of this material is still classified information.

Another type of heat shield is a three-inch-thick plate of beryllium, six feet in diameter. This is called a "heat sink." Beryllium has the quality of absorbing vast quantities of heat.

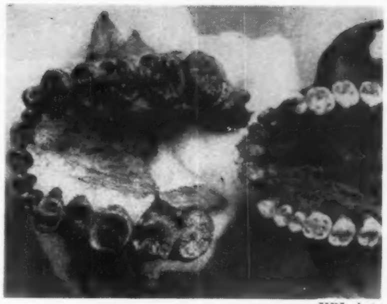
These heat shields will have a tough job. The Mercury capsule will plunge through the Earth's atmosphere at 17,000 miles an hour as it returns from its space flight. Several inches in front of this capsule, which resembles the smokestack on a pioneer locomotive, a cushion of air may reach temperatures of 10,000 degrees Fahrenheit. Inside the capsule will be one of the seven men now being trained for the historic flight. If this man is to survive, the heat shield life-saver must do its job well.

Ancient Skull Found

The skull of a youth who lived 600,000 to one million years ago was found by a British paleontologist (scientist who studies the various forms of ancient life). The skull is the oldest yet discovered of a tool-making man. In photo at right its huge upper teeth dwarf the upper teeth of an Australian aborigine.

Dr. Louis S. B. Leakey found the skull in the Olduvai Gorge, Tanganyika, South Africa. He started to explore that region 27 years ago.

Dr. Leakey described the skull as having enormous teeth, a small brain cavity, and a very large face. The skull belonged to a young man of about 18 who lived mainly on a diet of nuts. He had just begun to add mice, snakes, and lizards to his diet. In Dr. Leakey's opinion, the youth had probably died of some illness, most likely pneumonia, rather than violence. The body had been covered with thornbushes by the youth's comrades, said Dr. Leakey, to prevent hyenas from eating it. Soon after, a lake arose in the Olduvai Gorge, covering and preserving the remains.



UPI photo

Giant teeth *(left)* in newly found skull compared to Australian aborigine's jaw. (Details of "find" in story at left.)

The skull was dug out of a layer of earth in which archaeologists had been finding primitive stone tools for more than 30 years. Dr. Leakey stated: "We discovered the Olduvai skull on his living floor, with examples of the very primitive stone culture called Oldowan. On the same living floor were the bones of the animals, birds, and reptiles that formed part of his diet."

Parts of the skull were sent to the University of California, where tests will be made for its age. The skull contains potassium 40, a radioactive isotope that decays into argon 40. One ounce of potassium 40 decays into half an ounce of argon 40 in 1.25 billion years. Scientists can determine the age of the skull by measuring the amount of each isotope and comparing the ratio.

New Rocket Fuels

A revolutionary new family of liquid rocket fuels, developed after five years of intensive research, has been announced by the Navy.

Conventional rocket fuels now in use are bi-propellants. They consist of two elements. One is the fuel, such as kerosene. The other is the oxidizer, such as liquid oxygen, which permits the fuel to burn. The new rocket fuels are monopropellants. They combine the fuel and oxidizer in one liquid. This, the Navy announcement pointed out, "makes for a less complex rocket motor, with much less plumbing and with greatly increased reliability."

Until now, mono-propellant fuels had to be handled with great care. They would explode violently with the slightest mishandling. The new mono-propellants are remarkably stable and easy to handle. They can be dropped, pounded, or kicked around, and nothing happens. They can be heated to more than 300 degrees F. without exploding. Thus a rocket can be fueled at the manufacturer's plant, then stored for years.

today's scientists

Dr. FREDERICK SANGER
Molecule Juggler

Ten years of research on proteins led eventually to the Nobel Prize in chemistry for Frederick Sanger.

British Information Services photo

"Fellow students:

"I hope you will allow me to address you in this way, because I still consider myself a student, and I regard this as a great privilege. In spite of winning a Nobel Prize in chemistry, I realize that I still have much to learn. I feel sure that my colleagues will agree with me that we research workers always remain students. Therefore, we feel that we have a bond of contact and of friendship with you."

With these words Dr. Frederick Sanger, one of Britain's pioneers in scientific research, began an address to Swedish students. The occasion was a ceremony honoring the 1958 Nobel Prize winners, Dr. Sanger being one of them. Dr. Sanger's achievement: breaking down the structure of the molecule of the protein insulin—the life-preserving hormone of diabetics—and then building it up again! This was the first time one of the protein building blocks of life had been taken apart and put together.

What kind of a worker is Dr. Sanger? He enjoys working with his own hands in a small group. For him, he says, this is the most profitable way of doing research. As a research scientist, he is employed by the Medical Research Council, a British government organization.

The big question Dr. Sanger strives to answer is this: How far can chemistry go toward giving us an explanation of the life process?

This problem first fascinated young Sanger as an undergraduate student at St. Johns College, Cambridge, England. His interest in chemistry had been kindled at Bryanston School, a secondary school. It was in his last year at Bryanston that he began doing a great deal of his own laboratory work.

His thesis on amino acid metabolism earned him his doctorate at Cambridge University in 1943. He was now ready to begin the research on proteins that was to lead eventually to a Nobel Prize.

Why are proteins important enough for a man to spend 10 years developing a method for studying their structure? Why, especially, would he try to isolate and then identify the various components of the insulin molecule—a protein.

In announcing the Nobel Prize in chemistry for Dr. Sanger, the Swedish Academy of Science described the protein as "the most complicated of all substances occurring in nature. Many hormones, all enzymes so far known, viruses, toxins which cause disease, and antibodies which give immunity to disease, are all proteins. In all tissues of the body, in muscle, nerve, and skin, proteins form an essential functional constituent."

Let's look at the insulin protein. It is produced by the islets of Langerhans, groups of cells situated in the pancreas gland. This protein enables your body to utilize sugar for energy. Most of the energy for your body is produced by the breakdown of glucose (a form of sugar). The amount of glucose in your body normally remains constant. Should the amount become too low, convulsions and shock occur. If it becomes too high, coma may result.

Ten Years Studying Proteins

Insulin is one of the main factors controlling the glucose level in your blood. When your glucose level becomes too high, the cells in the islets of Langerhans are stimulated. They produce insulin. This is carried by the blood throughout your body. By a still unknown process, the insulin aids in removing glucose from your blood.

In some individuals, the islets of Langerhans cannot secrete sufficient insulin to keep the glucose at a normal level. This abnormality is called diabetes.

Insulin and all other proteins are made up of simpler units called amino acids (nitrogen-containing organic acids). These are strung together in long chains, or cables. Scientists know 24 different kinds of amino acids. Every type of protein molecule in your body owes its identifying characteristics not only to the kinds of amino acid units it contains, but also to the *arrangement* of these units.

By various processes, chemists were able to separate the amino acids of protein molecules and count these building blocks. But they still could not learn just how these amino acids were arranged in the protein molecule.

Until Sanger's work on insulin, no one had been able to determine the structure of even the simplest protein molecule.

Said the Swedish Academy of Science: "Sanger's methods and results have opened a road to the determination of their detailed structure, and thus one of chemistry's greatest problems has found its solution in principle."

Why did Dr. Sanger choose insulin for his investigation of proteins?

Insulin is available in a reasonably pure form. A knowledge of the exact pattern of the insulin molecule may lead to a fuller understanding of how insulin controls the oxidation of sugar in the body.

Although the structure of insulin was not known, its individual atomic components were known.

Dr. Sanger and his associates started to attack the insulin molecule in 1944 at the University of Cambridge. Their task: to work out the order of every amino acid link in the insulin molecule chain. This was not an easy task. There were thousands of possible ways in which they could be arranged.

First the insulin molecules had to be broken up into fragments. This was done by a chemical process known as acid hydrolysis. Hydrolysis is a reaction in which water acts upon a substance to break it up into one or more entirely new substances.

(Continued on page 26)

tomorrow's scientists

Project: Protein Content in Green Algae

Student:
James Geil
Parma Senior High School
Parma, Ohio
Science Achievement Awards Winner

Teacher:
L. Elizabeth Hawkins

[Discovering new sources of food is a problem facing practical scientists. One solution to this crucial problem lies in the production of algae on a large scale. In recent years there has been an intensified study of Chlorella in regard to this problem of food production, but investigations into other varieties of algae, concerning their nutritional value, is lacking. James Geil of Parma Senior High School, Parma, Ohio, has tackled the job of making comparative analyses of different varieties of algae in order to determine their nutritional values. Perhaps James' research will shed light on new sources of food for the future.]

Since proteins, rather than carbohydrates or fats, are our main nutritional need, my investigations were limited to the protein content of algae. As many algae as possible were analyzed, grown under standard conditions, for their percentages of protein.

In order to be able to determine what varieties of algae would yield the most protein, two things were needed: large quantities of algae and a method to analyze them. The branching and filamentous algae (Cladophora g., Cladophora, and Rhizoclonium) were collected directly from a pond and stream in Parma, Ohio. The unicellular algae were supplied by the State of Ohio Department of Health on agar slants in pure cultures.

CULTURING ALGAE

These algal cultures were transferred to 250 ml Erlenmeyer flasks and culture tubes. The flasks, each containing 40 ml of a solid nutrient medium, were used for the mass culturing of the algae. The culture tubes, each containing 7 ml of the same solid nutrient medium, were used to maintain pure cultures. Each container was then placed in an incubator.

In selecting a nutrient medium which was as unfavorable as possible to the growth of bacteria and fungi, yet so made up that it would not injure the delicate algal cells, Meiers solution, as described in the 1933 Smithsonian Institution Annual Report, pp. 373-384, was found to be most suitable. It was made up in the following proportions and then diluted to one-third:

Calcium nitrate	1.00 grams
Potassium chloride	0.25 grams
Magnesium sulphate	0.25 grams
Potassium acid phosphate	0.25 grams
Distilled water	1 liter
Ferric chloride	a trace

A solid medium was made by adding 2 per cent agar plus 2 per cent glucose to the mineral solution. The solution was heated slowly and stirred until the agar and glucose were dissolved. The mixture was then placed in clean Erlenmeyer flasks and culture tubes and sterilized in an autoclave for one-half hour. Each container then was quickly stoppered with sterilized cotton. After the medium had congealed, the flasks and slants were inoculated with a pure culture using a loop of fine platinum wire.

After inoculation, the cultures were placed in an incubator. The incubator was kept as airtight as possible, except for the filtered air inlet, to keep out any

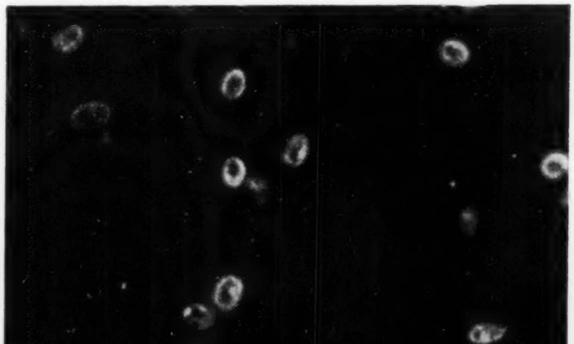


Photo from project by Larry Dahlkvist

Chlorella Pyreniodosa (1000 X) phase contrast-oil immersion.

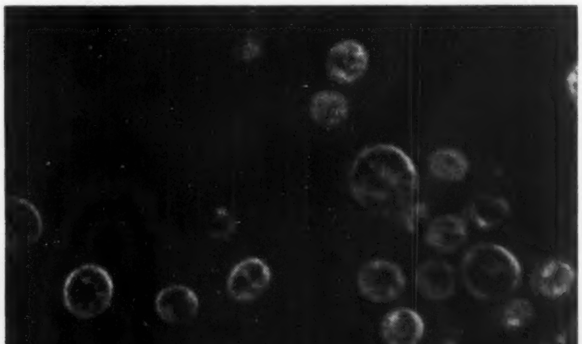
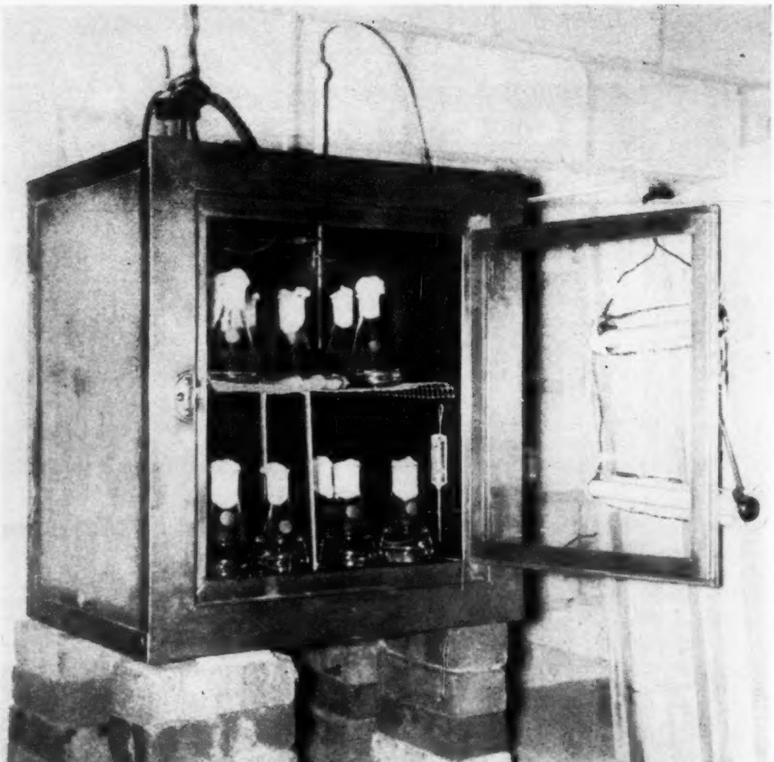
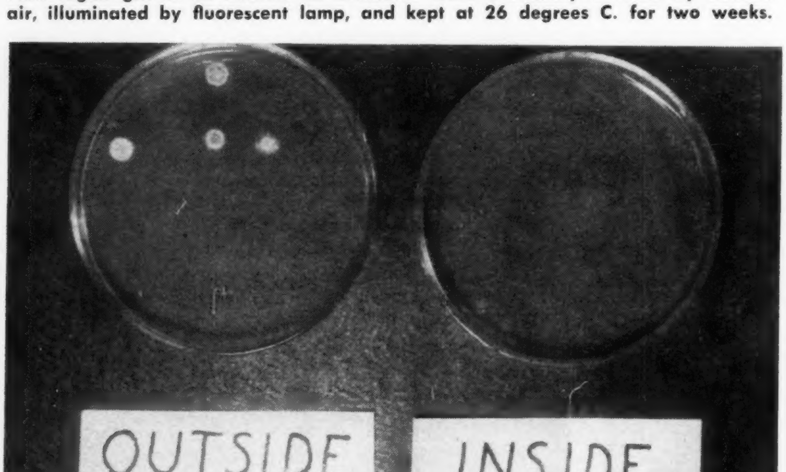


Photo from project by Larry Dahlkvist

Scenedesmus Obliquus (1000 X) phase contrast—oil immersion.



Pure algae grown on nutrient in incubator were constantly aerated by filtered air, illuminated by fluorescent lamp, and kept at 26 degrees C. for two weeks.



Petri dishes show that no bacteria grew inside incubator but did grow outside.

Microphotos were shot with hand camera using horizontal microscope arrangement.

foreign material. A wire shelf was used in the incubator to provide an even distribution of light, heat, and air. The incubator was raised ten inches from the floor for easier handling. The cultures were constantly aerated with filtered air, which was pumped into the incubator with a small air pump. The algae were continually illuminated by two 50 watt fluorescent lights. At the center of the incubator 400 foot-candles of light was measured. To avoid overheating of the algal cultures by the lamps, the lights were kept twelve inches away from the glass door in front of the incubator. According to the thermometers attached at the top and bottom of the incubator, the temperature was kept at 26° C.

Within two weeks after inoculation, the algae cultures were ready for harvesting. This was accomplished by scraping the algae cells off the solid medium and drying them under a 100 watt incandescent lamp (110° F.) for two hours. The dry weight of the sample was then measured on an analytical scale. After the algae was harvested, the nutrient medium was melted, placed in clean flasks, resterilized, and then inoculated again.

METHOD OF ANALYSIS

For the analysis of the dried algae, the Kjeldahl method was found to be suitable. The procedure of this method is as follows: first, the oxidation of the sample and the conversion of protein nitrogen into ammonium sulfate; second, the decomposition of the ammonium sulfate with strong alkali and the distillation of the ammonia evolved into standard acid; third, the titration of the standard acid with standard base; and fourth, the calculation of the percentage of protein in the sample from its weight and the volume of standard acid neutralized by the ammonia distilled.

Oxidation process. The oxidation of the sample was accomplished by heating it with concentrated sulfuric acid in the presence of copper sulfate as an oxidizing catalyst and the salt potassium sulfate.

A sample weight of 0.3-0.5 grams was used in the analyses. A slightly higher sample weight should have been used for more accurate results, but this proved impractical due to the small quantities of algae available. The sample was wrapped in filter paper to prevent any of it from sticking to the neck of the digestion flask when it was dropped into the flask.

Twenty ml of concentrated sulfuric acid were added to oxidize the organic matter and combine with the ammonia produced. In the oxidation, the carbon and hydrogen were converted to carbon

dioxide and water. Some of the sulfuric acid was reduced in the process to sulfuric dioxide. This sulfuric dioxide reduced the nitrogenous compounds to ammonia which, in turn, reacted with the sulfuric acid to form ammonium sulfate. The volume of the sulfuric acid in the flask throughout the digestion process was kept above 10 ml because the heat should not touch any part of the flask that was not in contact with the liquid, or a decomposition of the ammonium sulfate would result, and a loss of ammonia would occur.

Ten grams of potassium sulfate were added to raise the boiling point of the sulfuric acid and thereby speed up the oxidation. An oxidation catalyst (a crystal of copper sulfate) was added to speed up the oxidation of the organic matter.

The mixture in the digestion flask was heated over a low heat for five minutes. The heat was then increased so that the contents of the flask boiled briskly. In two hours the mixture lost its dark color, and the digestion was allowed to continue for an additional thirty minutes to insure complete oxidation.

Distillation process. Before the actual distillation, 150 ml of water were distilled through the apparatus to be sure that the distillation apparatus was completely clean and free from ammonia. After the ammonium sulfate-potassium sulfate-sulfuric acid mixture cooled, it was dissolved in 300 ml of water. At times the mixture solidified, and it was necessary to reheat it after the water was added to be sure that it was completely dissolved. The function of the water was to reduce the violence of the reaction when alkali was added.

50.00 ml of standard 0.1 N acid were placed, along with 5 drops of mixed methyl red indicator solution, in a 500 ml Erlenmeyer flask. This flask was placed under the condenser of the distilling unit in such a way as to be sure that the condenser tube extended beneath the surface of the acid in the flask.

80 ml of the Kjeldahl alkali solution (500 grams of NaOH dissolved in one liter of distilled water) was added to a distilling flask containing the oxidized mixture. A few pieces of granulated zinc were also added to prevent reaction due to superheating. The distilling flask was then quickly connected to the condenser. A Bunsen burner was ignited under the flask, and the contents of the flask were thoroughly mixed, using a rotary motion. After 200 ml of liquid were distilled, the flame was turned off and the receiving flask removed for titration.

Just before the distillation was stopped, the receiving flask was moved so that the tip of the distilling tube was out of the liquid. The outside of the distillation tube was then washed with distilled water, and the washings were collected in the receiving flask.

Titration. The excess acid remaining in the receiving flask at the completion of the distillation process was titrated. A blank test was run through the entire process with the sample test. This test corrects for the amount of ammonia derived from the chemicals which may contain traces of ammonium compounds or nitrates which could be reduced to ammonia in the process. The same reagents in the same proportions were used in the blank test as were used in the sample test. Sugar which contains no nitrogen was used in the blank test. The blank titration minus the sample titration represents the amount of acid neutralized by the ammonia from the sample, corrected for any ammonia derived from the reagents. This value was then converted into grams of protein, and the percentage of protein in the sample was calculated. A typical calculation is given below.

Calculation. Take, as an example, a .500 gram sample of Cladophora. 50.00 ml of 0.1 N acid was placed in the receiving flask for the sample test and a similar volume for the blank test. After distillation, 89.0 ml of 0.1 N alkali solution were used to titrate the excess acid in the blank, whereas 27.5 ml of the standard alkali solution were used to titrate the excess acid in the sample. The calculations are as follows:

$89.0 - 27.5 = 61.5$ ml of 0.1 N alkali solution equal to the ammonia distilled from the sample and corrected for any ammonia derived from the chemicals.

$61.5 \times 0.1 = 6.15$ ml of normal alkali solution, equal to the ammonia (or nitrogen) distilled from the sample.

$0.014 \times 6.15 = .0861$ gram nitrogen present in the sample. (1 ml of normal alkali solution is equivalent to 1 ml of normal nitrogen solution, which contains 0.014 grams of nitrogen.)

$.0861 \times 6.25 = .538$ gram protein present in the sample. (6.25 is the general protein factor for converting nitrogen into protein.)

$.538 + .500 \times 100 = 26.91$ per cent protein in the sample.

RESULTS OF ANALYSIS

According to the data collected, Chlorococcum, which contains 70.00 per cent protein, is best suited for growth as one of the future sources of protein. The remainder are as follows: Chlorella–65.18 per cent, Stichococcus –62.90 per cent, Scenedesmus–60.24 per cent, Pleurococcus–43.16 per cent, Cladophora g.–30.19 per cent, Cladophora–26.91 per cent, and Rhizoclonium –22.82 per cent. In the future, experiments cannot be limited to Chlorella alone but must cover other forms of algae with high percentages of protein such as Chlorococcum.

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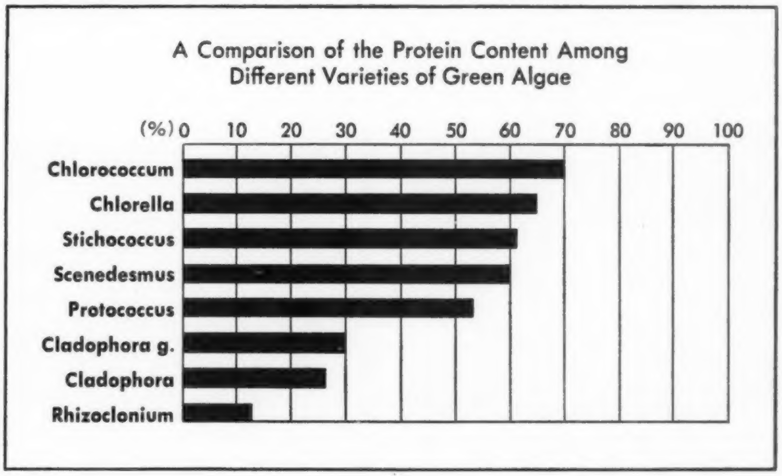


tomorrow's scientists

Project: Practical Uses of the Butternut

Student: Andrew Horton
Amherst Junior High School
Amherst, Massachusetts
Science Achievement Award Winner

Teacher: Ronald Fitzgerald

MY PURPOSE in this project was to gather more facts through experimentation and to investigate some of the practical uses of the butternut.

From the 17 experiments I performed, the following results are the most important.

1. A dye was obtained from the green husk of the butternut.
2. A satisfactory fertilizer was made from ground-up butternut husks.
3. Butternuts were used in several foods and proved to be tasty.
4. Butternuts will not keep in the open air or in damp, dark places.
5. Butternuts contain many food nutrients.

On the basis of the experiments I have performed, I suggest the following uses for butternuts in home and industry:

1. Dyes made from the butternut could be used in the dyeing industry.
2. Butternut husks could be used in fertilizers.
3. Butternuts could be used in many new and delicious forms of food.

I undertook this project because there is a butternut tree in our back yard and I have always wondered about uses for the butternut. Another factor that indirectly interested me in the project was a book I had read about George Washington Carver and his experiments with the peanut. I was really amazed by the foods Mr. Carver produced from peanuts and felt that I would like to do something similar.

I would like to acknowledge the help of the following people: Mr. Fitzgerald, my science teacher, made suggestions on experiments to perform and supervised some of them. Mrs. Griffith, my grandmother, cooked and prepared many of the foods for the food experiments. Major Horton, my father, typed the project paper for me.

BUTTERNUT DYE

First, from the green husks of the butternut, I obtained a dye, which varied in color from light yellow to a dark, greenish-brown. To obtain this dye, I chopped butternut husks finely, added water and boiled. I pressed the husks with a potato masher while they boiled. The contents were poured through a sieve and saved. In dyeing a piece of cloth I first put it through a bath of aluminum sulfate and sodium carbonate and allowed it to dry. Then the cloth was put in a pan with the butternut dye and boiled for about 20 minutes. After this the cloth was allowed to dry. When the piece of cloth had dried, it was washed once to remove small chunks of butternut husks that had settled on the cloth. The cloth was now color safe. (Bleach can not be used on this dyed cloth, as the color comes out when put into a bleach bath.) Members of my family wore pieces of this cloth without skin irritation. I conclude the dye does not harm the skin.

Ground-up butternut husks make a very effective fertilizer. To prove this, I took two pans and filled them to the same height with the same type of soil in both pans. About a tablespoon of chopped, green butternut husks were added to one of the pans. Three beans were planted in each pan. Two dishes under the pans were watered daily.

Butternuts can be used in many foods. In one experiment butternuts were added to cookies. Two dishes of cookies were served to eight people. Butternut cookies were in one dish, walnut cookies in the other. After the cookies had been consumed, the unsuspecting subjects were asked which cookies they liked best. All eight liked the butternut cookies.

In my last food experiment, I made butternut butter by chopping butternuts very finely, roasting them, melting them with pressure and heat, adding a very small amount of vegetable oil, and some salt and sugar. The butter was spread on cookies to which honey was added, then served to five women. They said it did not taste like nuts, had a smoky flavor, was somewhat like anchovies, and would probably go well with rye or pumpernickel bread.

FOOD NUTRIENTS

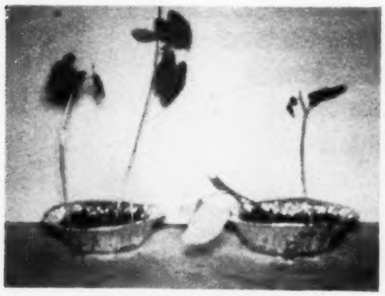
Butternuts contain many food nutrients. First, they contain fats. This can be proved by squashing butternuts on a piece of white paper. The oil squeezed out of the nuts makes the paper translucent, proving the butternut contains fats and oils. Butternuts contain protein. By putting a small amount of chopped butternuts in a test tube and adding two or three drops of concentrated nitric acid*, a yellow color appears, indicating the presence of protein. If the nitric acid is washed out and two or three drops of ammonia water added, an orange color appears, proving the presence of protein.

To test for starch in butternuts, I added finely chopped butternuts to one-half test tube of water and added a few drops of iodine. A purple color proved the presence of starch.

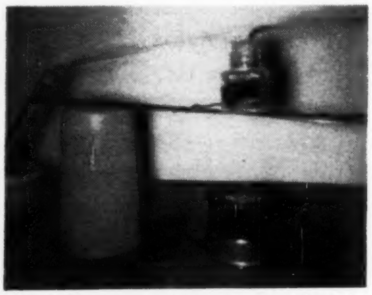
I also tested for minerals by burning a piece of a butternut until only a grayish-white ash remained. This grayish-white ash is made up of minerals.

I do not think the butternut will come into industrial or commercial usage to any great extent because there are not enough butternut trees. It would be impractical to raise them because of their large size and the large amounts of minerals they need. However, individuals might make good use of back yard trees.

*Nitric acid is dangerous. Use extreme caution.



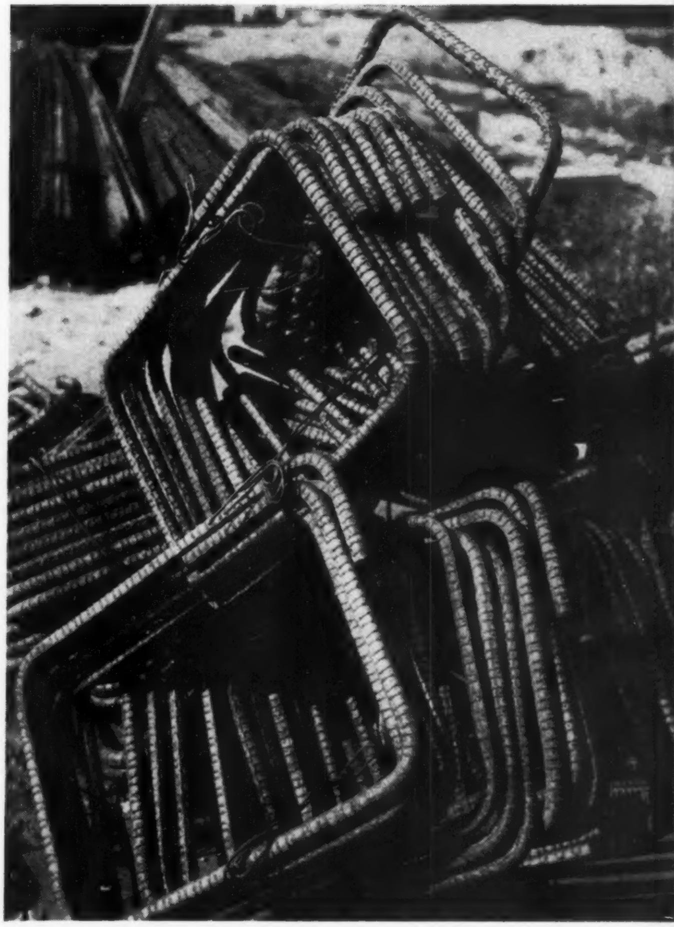
Pan at left contains ground-up butternut husks. Pan at right has plain soil.



This is the method Andrew used in his project to distill the butternut for oil.

Curiosity Catchers

It is curious how a stream erodes the outside of a curve more than the inside. Why should this stream be wearing away the resistant bank and not the sand and gravel on the inside?



Although iron rods and wires may have had no special coating or surface treatment, they seem to be more likely to rust where they have been bent or twisted. Why should this be so?

MOST OF US are curious about the things that excite our imagination—cars that travel on air, what the surface of the moon is like, or the bottom of the ocean.

Can the commonplace also excite your curiosity? To notice the thing that is only slightly strange can sometimes trigger a chain of events that lead to an invention or a discovery of very great importance.

The things that catch your curiosity may not lead you to cures for cancer, new ways to synthesize sugar, new explanations for radioactivity, or other equally important discoveries. But you will find that a well exercised curiosity can add more interest to the whole business of living.

To give you some of the fun of exercising your curiosity, *Science World* includes in each issue some Curiosity Catchers, things we hope will arouse your curiosity and spark it into planning experiments and investigations with the other members of your class.

For the science class that sends in the best plan of attack for following up each Curiosity Catcher, *Science World* will award a science reference book for the classroom shelf—a book of your choice!

Each class entry must be postmarked not later than 30 days after the date of the issue in which the Curiosity Catcher appeared. Address your entry to Curiosity Catchers, Science World, 33 West 42nd Street, New York 36, N. Y. Entries will be judged on how clearly the problem is worded, on how much additional information has been brought together, on the probable fruitfulness of hypotheses, and on the strategy with which experiments or investigations are planned or carried out.

Project and Club News

Tips for Science Fair Exhibits

IN the science fair exhibit, a student can express himself creatively—both scientifically by research and experiment, and artistically by design to compliment his research efforts. Many science fair exhibits seem to indicate that the student was enthusiastic about doing his science fair project but indifferent in displaying it.

Since creative art does not produce formulas as creative science does, these tips must be considered only as guideposts. Planning, common sense, and emotional response to design and color are very important.

Communicate with Design

The purpose of the exhibit is to communicate information. The subject matter should be limited to the presentation of one research principle with one final conclusion.

1. The design must be simple; by all means avoid excessive decoration.

2. To capture the viewer's attention immediately, use an exhibit title of a few words in large letters, or a single object as a center of interest.

3. Communicate one idea, and do it in about five and not more than ten seconds. Seems like a fleeting instant, doesn't it? But check the second hand on your watch to see how slowly five seconds pass.

4. Give the viewer's eyes a natural pathway to follow in designing the exhibit by a sequence arrangement of copy and objects. Since we read from left to right, it has become a habit for people to look at objects in the same manner also.

5. Design the exhibit for functionability, practicability, portability.
   A. Functional—the exhibit should be designed for the purpose of telling the story of the research and displayed material.
   B. Practical—number of components, setting up time, and limit of content must be considered.
   C. Portable—the exhibit should be compact, durable, and easy to transport as a unit.

6. Try to consider the point of view of the audience in designing. This is often helpful in avoiding serious pitfalls in design.

7. Allow yourselves sufficient designing and construction time.

8. To develop a design:
   A. Begin by making several rough sketches, considering both arrangement of material and color.
   B. Select the rough sketch that has most appeal to you, and do a dimension drawing of it, preferably to full scale.

Presentation Methods

There are many methods and combinations of methods that are used to display effectively. Here are a few suggestions:

1. Actual objects—can be displayed on wood bases or in plastic containers.

2. Animation—viewers are attracted by movement, such as a flashing light, or a turntable.

3. Participation—allow the audience to handle certain objects, or let them press a button to turn on lights or start the movement of a mechanism.

4. Demonstration—this is sometimes difficult, but often successful. In most cases, the exhibitor will not be present during judging to demonstrate so it is necessary that instructions be left for the judges to use.

The design of a science fair exhibit should express the spirit of the information and material being displayed. Therefore, your exhibit should be modern in character to be compatible with the principle you are presenting.

CLARENCE F. RUNTSCH
Head, Exhibits Branch
American Museum of Atomic Energy
Oak Ridge, Tennessee

Answers to Scientific Notation

(See page 28)

A. 1. 1.86×10^5
2. 6×10^6
3. 5.2×10^{-4}
4. 5.89×10^{-5}
5. 1.767×10^2

B. 6. 9×10^8
7. 2.8×10^8
8. 6×10^3
9. 1×10^5
10. 3×10^{-3}

C. 11. 2
12. 3×10^3
13. 2×10^{15}
14. 2.35×10^{11} dollars

Molecule Juggler

(Continued from page 20)

At ordinary temperatures these reactions are slight. To produce appreciable results, certain acids are used as catalysts. Acid hydrolysis breaks the insulin molecule into smaller molecules of protein "derivatives," with shorter and shorter chains of amino acids. Finally we arrive at the simplest units—amino acids.

After the amino acid groups were obtained, they were separated by chromatography. After isolating and identifying the components of insulin, the next step was to reassemble the bits, so that the complete structure of the molecule could be worked out. This task was like fitting together a jigsaw puzzle—and this is just how Dr. Sanger went at it.

Finding large pieces whose position in the molecular chain he was sure of, he kept adding the smaller pieces that were capable of clinging to them.

Finally he assembled two complete chains. These chains were composed of links of amino acids.

The year was now 1952. It had taken more than eight years to make the two chains. How were these chains interlocked? The chains were held together by "bridges" of sulfur atoms.

The result of his research: scientists now know how the amino acids of a protein are strung together.

At Last—Picture of Molecule

Insulin, a comparatively simple protein, has 51 amino acid units containing 17 different amino acids. They are found in two chains, one of 21 units, the other of 30.

The scientific world had, at last, a picture of one of the molecules that make up life.

In 1958 Dr. Sanger received the Nobel Prize in chemistry.

(Continued on page 31)

Answers to Crossword Puzzle

(See page 30)

■	B	O	R	O	N	■	A	R	G	O	N	■
B	■	S	E	N	■	H	■	B	A	R	■	O
O	S	■	D	■	S	O	L	■	B	■	A	L
Y	O	U	■	T	H	R	E	E	■	E	S	E
L	U	■	C	■	E	S	T	■	S	■	S	I
E	■	B	O	A	■	E	■	S	O	B	■	N
■	C	O	U	R	T	■	R	A	D	O	N	■
O	■	A	G	E	■	C	■	T	A	B	■	S
Z	N	■	H	■	F	R	O	■	S	■	A	T
O	A	T	■	A	C	I	D	S	■	O	R	E
N	B	■	R	■	S	E	E	■	P	■	T	E
E	■	R	I	P	■	S	■	B	A	T	■	L
■	A	N	O	D	E	■	X	E	N	O	N	■

The cars are safer . . . the roads are safer . . .

THE REST IS UP TO YOU!

It's great to be able to drive! To know you can go where things are happening and to know your friends depend on *you* to get them there. But *other* people are depending on you, too. Your parents are confident that you have the ability to drive safely, maturely . . . that's why you have the car. And the traffic officials who issued your license are banking on your good judgment, too.

Many others are concerned with making sure you have every opportunity to drive safely . . . and drive again. Automotive engineers have made today's cars the safest ever built, with better brakes, better tires, steering and lighting, and greater all around visibility. Traffic experts have come up with expressways, divided highways, interchanges, better lighting and easily understood traffic signs and signals.

Yes, a lot of folks are trying to make sure that you are safe when driving, but in the end, they all must depend on *you* to cooperate. And safe driving makes sense, even aside from your safety and that of your friends and others on the road . . . the more careful you are, the more often you'll drive the car.

GENERAL MOTORS — **A CAR IS A BIG RESPONSIBILITY . . . SO HANDLE WITH CARE!**

Meeting the Test

The One, Two, Threes of Scientific Notation

By THEODORE BENJAMIN

THE Mt. Palomar telescope can photograph galaxies that are 25,000,000,000,000,000,000,000 miles away. It takes an electron .00000000000000000003 seconds to revolve around the nucleus of a hydrogen atom. In modern science we must be prepared to use large and small numbers. In addition to using them in calculations, we must have some idea of their size or magnitude. Were you able to read the first number above as 25 sextillion miles? Can you imagine how cumbersome calculations with such numbers could be!

Science and mathematics have developed an easy, compact way of handling these very large and very small numbers. It is most important that every science student learn this rather simple method and be able to apply it.

Any number can be written as the product of a number which is a power of ten. For example, we can write 852 as 8.52×100. Now 100 can be written as 10×10 or 10^2. Thus, 852 can be written in power of ten notation as 8.52×10^2. Note that in this system we express the desired number by the product of a number less than ten and by ten raised to some exponent.

Let us see how we can express a number like 25,000 in this system. It can be written $2.5 \times 10{,}000$. Since 10,000 is 10^4, we can write the number in our shorthand way as 2.5×10^4. We read this number as "two point five times ten to the fourth."

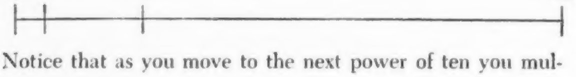
A convenient way of thinking about this method of notation is to realize that the exponent of the number ten (if it is plus or positive) is the number of places the decimal has to be shifted to the right to give you the number in the conventional system. Thus, 7.8×10^3 is 7,800. If we take a number like 6×10^{23} and want to write it out in our usual fashion, the number would consist of 6 followed by 23 zeros.

In going from the conventional system to the power of ten notation, just count the number of places the decimal has to be shifted to the left to leave a single digit to the left of the decimal place. The number of places the decimal is shifted is the power of ten to which the number remaining must be raised. You will notice that the power of ten is one less than the total number of digits. For example, let us convert a large number such as three billion seven hundred eighty thousand.

$$3\underbrace{780000}_{6\,5\,4\,3\,2\,1}. = 3.78 \times 10^6$$

In our scientific notation, the Mt. Palomar telescope can photograph objects 2.5×10^{22} miles away.

In using our power of ten notation you must not think of 10^2 as being half as large as 10^4. If you draw a line hundreds of feet long and then reduce the picture, leaving out some of the numerals, it would look something like this:



Notice that as you move to the next power of ten you multiply by ten, so that 10^4 is actually 100 times larger than 10^2.

For very small numbers a similar system is followed. The number .0057 can be written as $5.7 \times \frac{1}{1{,}000}$ or $5.7 \times \frac{1}{10^3}$.

Mathematical shorthand for $\frac{1}{10^3}$ is 10^{-3}. Therefore we write our number as 5.7×10^{-3}. With small numbers, the exponent which indicates the power of ten is one more than the number of zeros to the right of the decimal point and the exponent is given a negative sign to indicate that the decimal has been moved to the right rather than to the left, as in large numbers. Fifty seven hundred-thousandths is written as

$$.\underbrace{0005}_{1\,2\,3\,4}7 = 5.7 \times 10^{-4}$$

The time is takes an electron to revolve around the nucleus of a hydrogen atom is 3×10^{-20} seconds.

Not only does the power of ten notation give us a convenient way of expressing large and small numbers, but it also provides us with a simple way of multiplying and dividing. 2×10^4 times $3 \times 10^{10} = 6 \times 10^{14}$. To multiply, all you need do is to multiply the two "stem" numbers (2×3) and append to that the power of ten equal to the sum of the two exponents. Thus 8×10^5 times $5 \times 10^3 = 40 \times 10^8$ or better, 4×10^9.

Don't forget that adding a negative number to a positive number actually means that you must subtract the negative one from the positive, thus adding them agebraically.

2×10^7 times $3 \times 10^{-4} = 6 \times 10^3$

4×10^3 times $2 \times 10^{-7} = 8 \times 10^{-4}$

In dividing, subtract the exponent of the number by which you divide from the exponent of the other number:

6×10^8 divided by $3 \times 10^5 = 2 \times 10^3$

Remember again, that in subtracting a negative number from a positive one, we, in effect, add the two numbers

9×10^4 divided by $3 \times 10^{-8} = 3 \times 10^{12}$

8×10^{-12} divided by $4 \times 10^{-7} = 2 \times 10^{-5}$

Our way of writing numbers also makes it easy to determine what is called order of magnitude. The order of magnitude is the power of ten closest to the number. In a forthcoming issue we will explain this system of notation.

Try your hand on the following problems in power of ten notation. Answers will be found on page 26.

A. Write the following in powers of ten notation:
1. 186,000
2. 6,000,000
3. .00052
4. .0000589
5. 176.7

B. Multiply:
6. 3×10^3 by 3×10^5
7. 4×10^4 by 7×10^3
8. 3×10^{10} by 2×10^{-7}
9. 2×10^6 by 5×10^{-2}
10. 1×10^4 by 3×10^{-7}

C. Divide:
11. 8×10^4 by 4×10^4
12. 6×10^7 by 2×10^4
13. 3×10^{10} by 1.5×10^{-5}
14. The national debt is 235 billion dollars. Express in power of ten notation.

IT HAPPENS BEFORE ENLISTMENT!

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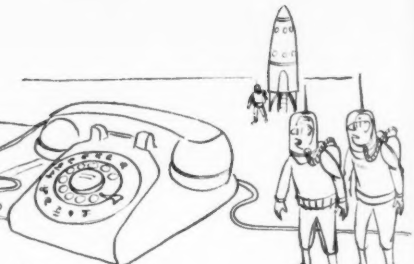
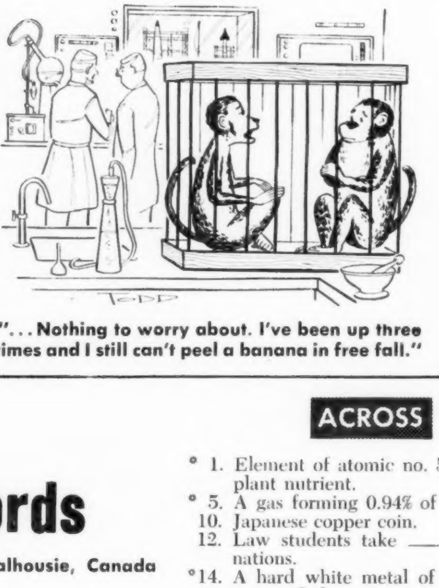
GRADUATE SPECIALIST

US ARMY

sci-fun

"Let's get out of here!"





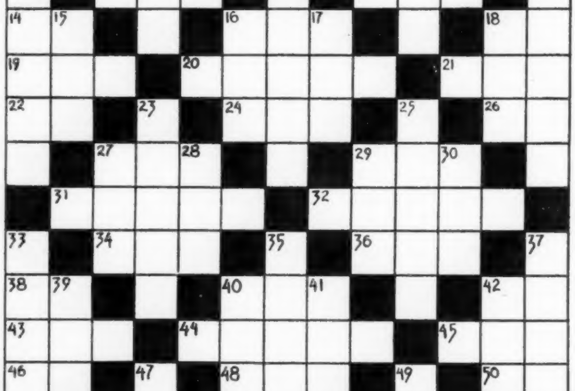
"... Nothing to worry about. I've been up three times and I still can't peel a banana in free fall."

Crucibles to Crosswords

By Francine Landry, Our Lady of the Sacred Heart Academy, Dalhousie, Canada

★ Starred words refer to chemistry

Students are invited to submit original crossword puzzles for publication in *Science World*. Each puzzle should be built around one topic in science, such as astronomy, botany, geology, space, electronics, famous scientists, etc. Maximum about 50 words, of which at least 10 must be related to the theme. For each puzzle published we will pay $10. Entries must include puzzle design, definitions, answers on separate sheets, design with answers filled in, and statement by student that the puzzle is original and his own work. Keep a copy as puzzles cannot be returned. Give name, address, school, and grade. Address Puzzle Editor, Science World, 33 West 42nd Street, New York 36, N. Y. Answers to this puzzle are on page 26.



ACROSS

*1. Element of atomic no. 5, an essential plant nutrient.
*5. A gas forming 0.94% of the air.
10. Japanese copper coin.
12. Law students take ________ examinations.
*14. A hard white metal of the platinum group of elements, atomic weight 190.2 (*symbol*).
*16. A liquid colloidal solution.
*18. Most abundant metal in the earth's crust (*symbol*).
19. In French, *vous* means ________.
*20. Lithium has atomic no. ________.
21. East-south-east (*abbr.*).
*22. Rare earth element of atomic no. 71 (*symbol*).
24. French: je suis, tu es, il ________.
*26. A non-metallic element second to oxygen in abundance (*symbol*).
27. Large snake that crushes its prey.
29. Catch the breath in weeping.
31. Place where justice is administered.
*32. Heavy, gaseous, radioactive element.
34. Dinosaurs lived in the Mesozoic Era or the ________ of Reptiles.
36. Name of the book club sponsored by *Scholastic Magazines* (*initials*).
*38. This element is called spelter in the metal trades (*symbol*).
40. To and ________.
*42. Element of the halogen family, atomic no. 85 (*symbol*).
43. A cereal plant.
*44. Hydrogen compounds.
45. Metal is extracted from this.
*46. Element of atomic no. 41 (*symbol*).
48. Homonym of sea.
*50. Element of atomic no. 52 (*symbol*).
51. Tear.
53. You hit a baseball with this.
*55. Positive pole of an electrical source.
*56. Colorless, totally inactive gas.

Molecule Juggler

(Continued from page 26)

The 41-year old scientist describes his work as being "useful mainly in analyzing other proteins. But, since proteins are the most important substances in the human body, understanding them is, in the long run, a step forward in fighting diseases which attack the body."

Dr. Sanger's message to young people: "We all dream about what we will be and what we will do. My advice to you would be to follow those dreams as far as possible and try to do the thing that really interests you, and you feel is really worthwhile. Especially in science, we need young people with plenty of enthusiasm and new ideas.

"It is from you students that we expect the scientific advances of the future and a very exciting and interesting future it is likely to be."

Sound advice from a man who practices what he preaches. Young Frederick Sanger had a dream once and followed it. Years of hard work and patience made his dream a reality. The result: a chemical feat of the first order!

DOWN

°2. Element of atomic no. 76 (*symbol*).
3. Little ________ Riding Hood.
4. *Life* ______ *the Mississippi*, by Mark Twain.
°6. Soft, silvery white metal of atomic no. 37 (*symbol*).
7. Chatter (*colloq.*).
8. Either, ________; neither, nor.
°9. He formulated the law that the volume of gas varies inversely with the pressure.
11. A solid-hoofed mammal.
°13. Vegetable oils are mainly ________.
15. French bronze coin.
16. Nominative pronoun, feminine.
17. A served tennis ball that hits the net, but is otherwise good.
18. Quadruped smaller than horse.
23. Expel air from the lungs with noise made by the opening of the glottis.
°25. Drinks made of H_2O charged with CO_2 and flavored.
27. Long, fur scarf.
28. I am; you ________.
29. Sixth planet from the sun (*abbr.*).
30. A woman's or child's short haircut.
°33. Unstable, bluish gas having a strong, pungent odor.
35. Weeps.
°37. A commercial form of iron.
39. Seize in arrest (*slang*).
°40. Fellow of the Chemical Society (*initials*).
41. Pindar and Horace wrote this type of poem.
42. ________ for art's sake.
47. Capital of Brazil, ________ de Janeiro.
49. Greek god of flocks and pastures.
°51. Element (of helium group) once called radium emanation (*symbol*).
°52. Silver-white ductile metal that does not tarnish in air (*symbol*).
53. Exist.
54. Keats' poem, "______ a Nightingale."

4. Of what practical importance may oceanography be?

5. Which phases of oceanography are of special interest to chemists? geologists? biologists? statesmen? meteorologists?

Scientific Notation (p. 28)

About This Article

As modern instrumentation extends both inwardly and outwardly the realms of space, time, matter, and energy, it becomes necessary for us as science teachers to train our students to think and express themselves in mathematical terms that are appropriate to our time and the subject matter.

Dr. Benjamin's article is therefore timely fare, not only for the physics student, but also for students in the other sciences. His article might well serve, too, as a reminder to teachers—whether they are dealing with the sizes of microorganisms, the number of gas molecules in a unit-volume, or the ages of sedimentary rock—to use power-of-ten notation and to encourage its use by students.

—Zachariah Subarsky

Space, Spiders, and Specimens

By RICHARD J. HURLEY

PUBLISHERS of science books for children and young people this fall have literally and literarily adopted the National Book Week motto: "Go Exploring in Books." They are backing it up with release of approximately 125 new books which range in subject from dinosaurs to space travel.

Increased attention to science and provision in the National Defense Education Act for grants to school libraries for equipment and printed materials (other than textbooks) combine to account for the recent upsurge in science writing. They have sparked other supplementary materials and programs, too.

Of general interest is *Exploring Science* (World), one of the publisher's beautiful Rainbow productions with 1,400 illustrations, 70 in color. Edited by J. N. Leonard of *Time*, it describes man's world and what he is doing with it. A science encyclopedia concentrating on chemistry, physics, and astronomy is the *Doubleday Pictorial Library of Science* (Doubleday), edited by Sir Julian Huxley. It also is richly illustrated. The prolific Isaac Asimov defines 1,500 scientific terms—from Academy to Zodiac—in his *Words of Science* (Houghton), a readable account of the history and root meanings of words. *The Tools of Science* (John Day), by veteran Irving Adler, ranges from yardsticks to cyclotrons in measuring, weighing, mixing, melting, and freezing. It, too, is well illustrated.

Do-it-yourself is good fun in spite of smell and smoke. Leonard deVries' *Book of Experiments* (Macmillan) describes 150 projects in chemistry and physics. George Barr's *Research Ideas for Young Scientists* (Whittlesey) includes such facets as time, distance, sound, and light, along with prosaic topics.

Budding naturalists will delight in another of Professor Glenn O. Blough's books, *Soon After September* (Whittlesey), in which birds migrate South and animals den up for the winter. *Animal Habits* (Morrow) continues the excellent series by George F. Mason on animal behavior and gives answers to such questions as: Why do beavers build dams? How do foxes outwit the hound and trap? Ted S. Pettit, conservation director of the Boy Scouts, presents the relationships between plants and animals and the conservation angle in *Web of Nature* (Doubleday). *Strange Partners* by Sigmund Lavine (Little), explores cooperation among wildlife in protection, shelter, food and the like, above ground, underground and under the sea. The Glenn Blough title is for intermediate grades; the others are for junior high school.

Mentioning series, there are four new titles in the *All About* series (Random): *All About the Jungle*, by Armstrong Sperry, . . . *Prehistoric Cave Men*, by Epstein & Williams, . . . *The Ice Age*, by Patricia Lauber, and . . . *Archaeology*, by Anne Terry White. Random House also has begun an *Easy to Read Science* series for third grade level.

Birds are represented by *Feathers and Flight* (Macmillan), by the Out-of-Doors series author, Clarence J. Hylander. Divided into such convenient chapters as water, game, perching birds, it is a splendid elementary ornithology for junior-senior high. Dorothy Shuttleworth has another attractive and informative "Story" in her *Story of Spiders* (Doubleday).

Dinosaurs roam the book shelves in numerous titles. The well-known team of Lois and Louis Darling has contributed *Before and After Dinosaurs* (Morrow), which relates the reptiles of today and aeons ago. Darlene Geis' *Dinosaurs and Other Prehistoric Animals* (Grosset) is for upper geologists who want their mammoths frozen or in tar pits.

For a bit of botanizing, we recommend *Plants That Changed the World*, by Bertha S. Dodge (Little), a Junior Literary Guild selection for older readers. Plants useful to man for drugs, rubber, rope, and the like are dramatically described. Millicent Selsam's *Plants That Heal* (Morrow), deals with herbs, drugs, and poisons. Patricia Lauber's *Our Friend the Forest* (Doubleday) is also a JLG selection and a combination of botany, conservation, and forestry. She is also the author of *The Quest of Galileo* (Garden City Books), the first of a new series to show how great scientists work. Delia Goetz continues a distinguished series in *Grasslands* (Morrow), for intermediate grade consumption. The people, animals, and products of the prairies, steppes, and savannahs are well portrayed in text and picture.

Going into orbit, we find Roy A. Gallant with his seventh "Exploring" book, *Man's Reach into Space* (Doubleday). Reaching outer space is one problem but survival is another. Homer E. Nevill, Jr., of the National Aeronautics and Space Administration, in his third science book, *Window in the Sky* (Whittlesey), describes the upper atmosphere.